ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 60. No. 26. 220 Broadway, New York, December 24, 1908.

TABLE OF CONTENTS.

LEADING ARTICLES: Page.

Some Problems in Designing the Kern River No. 1 Hydro-Electric Power Plant (illustrated); F. C. Finkle. 701

Tests on the Effect of Electric Current on Concrete (illustrated); U. James Nicholas. 710

The Proposed Electrification of the Terminal System of the Illinois Central R. R. in Chicago. 713

The Association of German Portland Cement Manufacturers; Summary of Proceedings for 1908—New German Cement Specifications; Robert W. Lesley and E. W. Lazell. 714

Richard H. Soule (with portrait). 721

A New Precise Measurement Method with Special Line Clinometers and Tape Stretchers; Edward H. Holden. 715

A Report on the Foundations and Construction of the Gatun Dam (illustrated) 722

Experimental Hydraulic-Dredge-Fill Dams at Gatun; Made for the Isthmian Canal Commission (illustrated); C. M. Saville, M. Am. Soc. C. E. 723

A Wedge Rail Fastening for Steel Ties (illustrated). 728

Storage of Coal Under Water and Tests of the Weathering of Coal (illustrated) 729

Scheme of the Boston Harbor Tests on the Effect of Sea-Water on Concrete. 729

Resolutions Adopted by the National Rivers and Harbors Congress. 731

EDITORIAL. 717

Panama Work and the Responsibility of the Engineering Profession—Electric Traction on the Illinois Central Ry.—Changes in Ferry Transportation Around Manhattan Island—Forests and Stream-Flow—A Design of a Hydro-Electric Plant.

Concrete as a Conductor of Electricity. 718

LETTERS TO THE EDITOR. 719

Contemporaneous Tests to Determine Time of Concrete Form Removal; Ransome Concrete Machinery Co.—The Corps of Engineers and the President's Message; C. M. Miller—Some Useful Hints to Engineers Applying for Positions—Forests, Snowfall and Stream Flow in the Mountains of Wyoming; Clarence T. Johnston—Notes and Queries.

ENGINEERING NEWS OF THE WEEK. 730

PERSONALS. 732

ENGINEERING SOCIETIES. 732

SOME PROBLEMS IN DESIGNING THE KERN RIVER NO. 1 HYDRO-ELECTRIC POWER PLANT.

By F. C. FINKLE.*

In designing the hydro-electric power plant of the Los Angeles Edison Electric Co., on Kern River, California, which was completed last year, some very important problems in hydro-mechanics were encountered and solved successfully. It has been the purpose of the writer to discuss some of these as of possible interest to other engineers, but since completing the work he has not found time to do so until now.

Fig. 1. Spilling Flume.

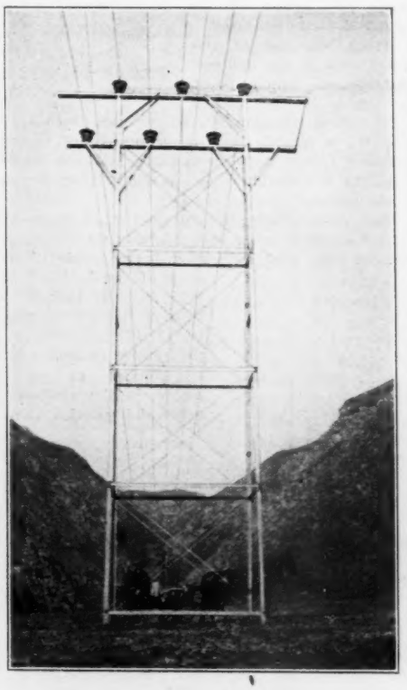

Fig. 2. Transmission Line Tower.

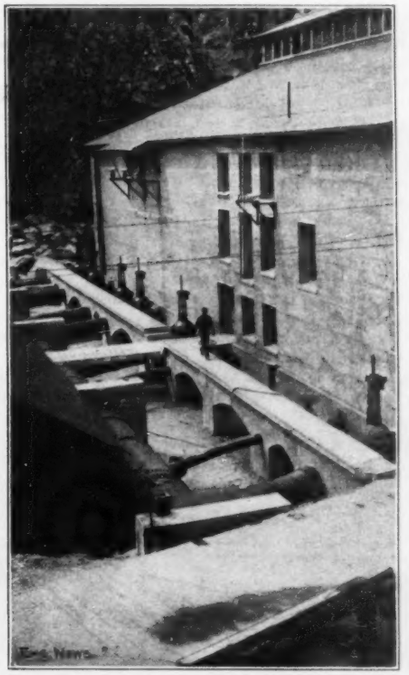

Fig. 3. Rear of Power House Showing Header and Branch Pipes, with 28-in. Gates.

VIEWS AT THE KERN RIVER POWER PLANT.

The power installation to which this article refers is the seventh hydro-electric plant designed and constructed for the Los Angeles Edison Co., and is the first of five such plants planned by that company on Kern River. Before entering on the technical design of the plant, a brief description of the water supply and general plan of the development may prove of value.

GENERAL DESCRIPTION OF THE PLANT.

The Kern River is one of the large rivers flowing from the Sierra Nevada Mts. into the San Joaquin Valley in California. Its mountain catchment area is approximately 2,200 sq. mi., ranging in elevation from 1,000 to 15,000 ft. above sea level. Mount Whitney, which is the highest mountain on United States territory outside of Alaska, is at the headwaters of Kern River, and there are a dozen other peaks around 14,000 ft. in elevation.

The snows never melt away completely at these high altitudes, the forests within the drainage area are practically untouched, and the slopes and ravines are well covered with glacial drift. These conditions are favorable to a well regulated runoff, which makes the stream a good one for power development without the necessity of constructing large storage reservoirs.

The minimum flow in ordinary years is above 400 sec.-ft., much higher in wet years, and half as much for a short period in dry years. Thus, we can readily see that, while storage reservoirs would be of some value, they are not a necessity, as the deficiencies occur so seldom and even then for so short a period that the usual steam plant relay for an hydraulic installation can make them up.

The first location selected by the Edison Electric Co. was near the mouth of the river, where all the mountain drainage area, except about 20 sq. mi., is tributary to the plant. The fall of the river is also the greatest near its canyon mouth, making this location the best on the stream.

The power plant, known as Kern River No. 1, is a 20,000-KW. installation at normal rating, but with 35-degree electrical equipment guaranteed for 25,000 KW. continuous load, and an hydraulic capacity for 30,000 KW.

The works consist of a diverting dam, controlling gates, intake section, conduit mostly of tunnel, forebay, force main, header and branch pipes, power-house, hydraulic impulse turbines, complete electrical equipment, tail races, spillway and steel tower transmission line to Los Angeles with main substation in that city.

The diverting dam is of cyclopean concrete, about 30 ft. high above the stream bed, 35 ft. to bed rock below the stream bed, and 203.5 ft. long on the crest. It is of the overflow type, designed along conservative lines, and is well anchored into the bed rock at the foundation and both abutments. Fig. 4 shows the intake end of this dam and Fig. 5 gives a plan and cross-section of the screen, gates and upper end of the intake tunnel.

The gates for controlling the water and silt are in two sets, both of which are operated with

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oil-pressure cylinders. The lower pair is placed in the drainage tunnel, which underdrains the pond below the level of the stream bed, and serves the purpose of sand sluices, or may be used to carry the entire river beneath the intake in an emergency. (Fig. 7.)

The upper pair of gates is for regulating the quantity of water to be diverted into the tunnel. (Fig. 9.) When these gates are lifted the full capacity of the tunnel conduit is diverted, while their partial closing reduces the flow into the

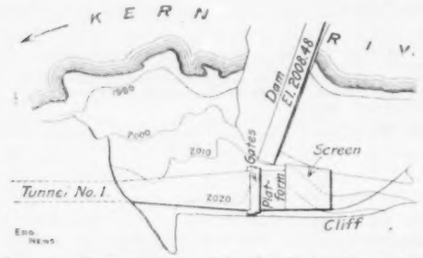

Fig. 4. General Plan of Intake End of Diverting Dam, Kern River, No 1, Hydro-Electric Power Plant.

tunnel and throws the rejected water over the diverting dam.

The intake section of the tunnel has been specially designed to admit the quantity of water required to fill the conduit lower down (Fig. 5). This will be discussed in detail, later, from a technical standpoint.

The conduit consists of 19 tunnels, aggregating 42,910.5 ft. in length, six flumes aggregating 1,520.7 ft. in length, and eight covered concrete conduits aggregating 503.5 ft. in length. The total length of the gravity conduit from the diverting dam to the forebay is therefore 44,944.7 ft. This is divided into separate sections for each type of construction.

The water-carrying section of the tunnels, which is 8 ft. wide by 7 ft. deep, is lined with concrete and plastered with cement mortar throughout, and the overhead section is arched with concrete, where the formations require it. (Fig. 6.)

Five of the flumes are of timber, those portions of the structure in contact with water being of clear California redwood (Sequoia Sempervirens) from the butts of trees grown on swampy land, and the remainder of clear, first growth Oregon fir. (Fig. 8.)

One flume, 49.9 ft. long, consists of steel framework supporting a box or channel of expanded metal in concrete and plastered with cement mortar. (Fig. 12.)

The covered concrete conduits are of the same form as the tunnel sections, with overhead concrete arch. The thickness of concrete surrounding the section of these varies according to the formation of the ground in which they are constructed.

The forebay is at the lower end of the gravity aqueduct and directly over the force main, which connects with the bottom of the forebay instead of the side as is ordinarily the practice. This departure is due to the new ideas adopted in designing the force main. The location of the forebay is on the mountain side at an elevation of 879 ft. above the power-house floor, and it is constructed wholly in excavation. The design is of reinforced concrete, with hand-operated geared gates for controlling the quantity of water passing towards the screens over the force main inlet.

In designing a force main for accumulating the pressure from the forebay to the power-house, with which to drive the impulse turbines, a most radical departure from the ordinary practice of placing a heavy pipe on the surface of the ground was made.

The plan of this part of the work, as well as some of its history, has been described and illustrated quite fully in Engineering News for March 21, 1907.* Some further matters of a technical nature will be referred to hereinafter.

From the end of the solid rock in the inclined tunnel, at which point a taper is introduced, contracting the diameter of the pipe from 7½ to 5¼ ft., a header pipe tapering evenly to preserve a nearly uniform velocity, as each branch pipe to the turbines is diverted from it, was constructed.

The power-house is constructed of reinforced concrete, with steel roof. Including the transformer cells and switchboard the inside dimensions of the building are 164 ft. in length by 66½ ft. in width (Figs. 10, 11, 17). A feature of the power-house, which is worthy of special notice, is the method of neutralizing the force of the jet, when it is deflected from the buckets.

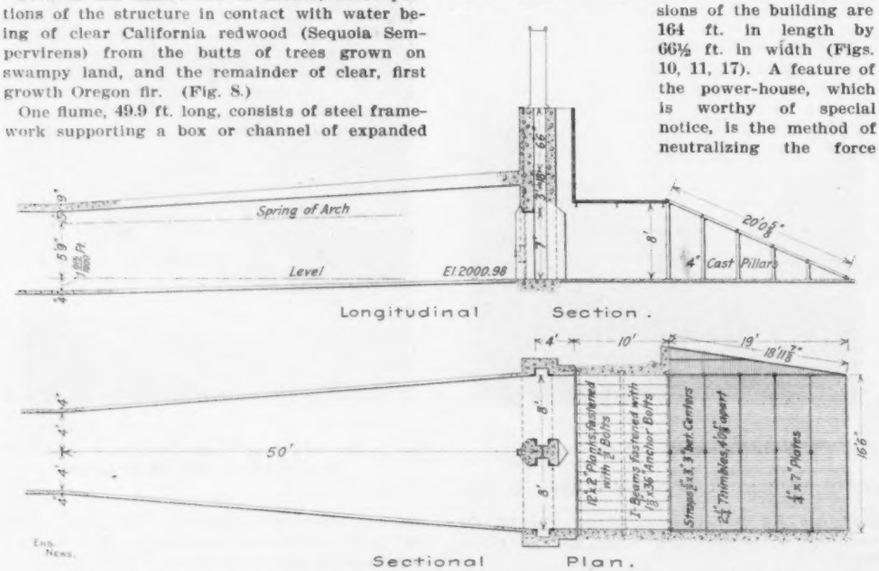

FIG. 5. PLAN AND SECTION OF SCREEN, GATES AND UPPER END OF INTAKE TUNNEL, KERN RIVER POWER PLANT.

The water wheels, which are of hydraulic impulse turbine type, were manufactured by the Allis-Chalmers Co., of Milwaukee, Wis. There are eight generator wheels, two for each unit, and each pair of wheels is capable of delivering 10,750 brake HP. on the generator [illegible] ft., or a total of 43,000 brake HP. for the [illegible] allation. (Fig. 18.)

The two exciter units have water [illegible] heels of the same type as those for the gen[illegible]tors, but only one rotor for each unit. Speed [illegible]gulation for both generators and exciters is [illegible]ned by means of the Escher-Wyss type of hydraulic governors, which are oil actuated and driven by silent chains.

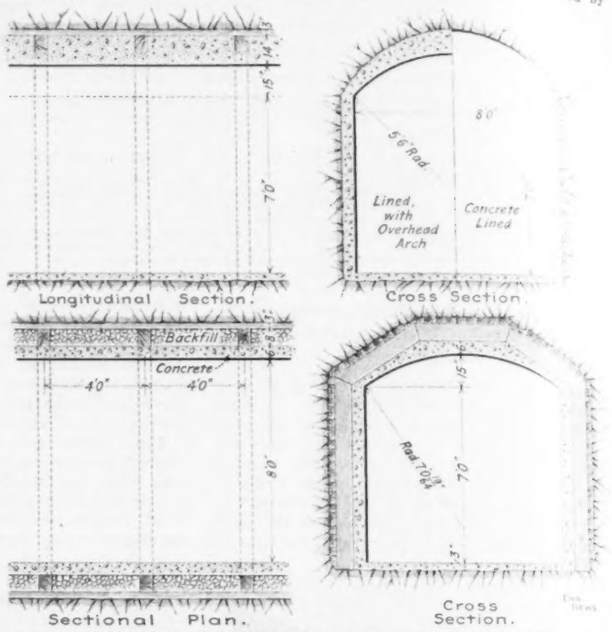

FIG. 6. CROSS-SECTIONS OF KERN RIVER POWER PLANT TUNNEL, SHOWING CHARACTER OF LINING.

The electrical equipment was all furnished by the General Electric Co. and is standard in every particular. There are four generator units of the revolving field type, for 125-volt excitation. These generate alternating three-phase current at 2,300 volts, 50 cycles. The speed of the generators, which is 250 r. p. m., was determined by the design of the turbines, as hereinafter explained. The normal rating of each generator is 5,000 KW., or 20,000 KW. for the installation. They are capable of carrying 25% overload continuously, or 25,000 KW., and 50% overload for a few hours, which makes the maximum capacity of the installation 30,000 KW., or 40,000 E. H. P.

There are two exciter units of 250 KW. each, 430 r. p. m., D. C. 125 volts. There are thirteen 1,667-KW. oil-filled, shell-type, oil-circulated transformers in boiler plate cases. These transformers are arranged in four banks with one spare, are 2,300 volts primary and 75,000 volts secondary, delta to Y. Intermediate taps for 37,500 and 56,250 volts are provided on the secondary side.

The electrical output of the plant is handled by means of a compact remote control switchboard, located on a platform gallery overlooking the entire station floor. All the latest and most highly improved electrical apparatus, such as switches, lightning arresters, choke coils, etc., made by the General Electric Co., are installed for rendering the operation of the plant as easy and safe as possible.

Individual tail races lead from each of the impulse turbines. These are of concrete, lined with boiler plate and provided with deflectors. They all open into the main tail race running parallel with the building and discharging over weirs into the river. (Fig. 19.)

In order to provide a way of escape for water not taken through the force main, a spillway was constructed from the forebay back to the river. The gravity aqueduct is always carried full of water, while the draft at the power house is variable, depending on the load carried by the plant. Thus, the surplus water must be returned to the river as quickly as possible, in

*"The Cave-in of an Inclined Shaft and Subsequent Rescue of an Entombed Miner, at Bakersfield, Cal.," by F. C. Finkle.

order not to injure the irrigators, who use the water below the power plant.

The formation around the forebay was of such a loose nature, that some kind of a channel had to be provided for this purpose. The material selected was redwood and a flume with about 1 on 1½ slope was built down the mountain side.

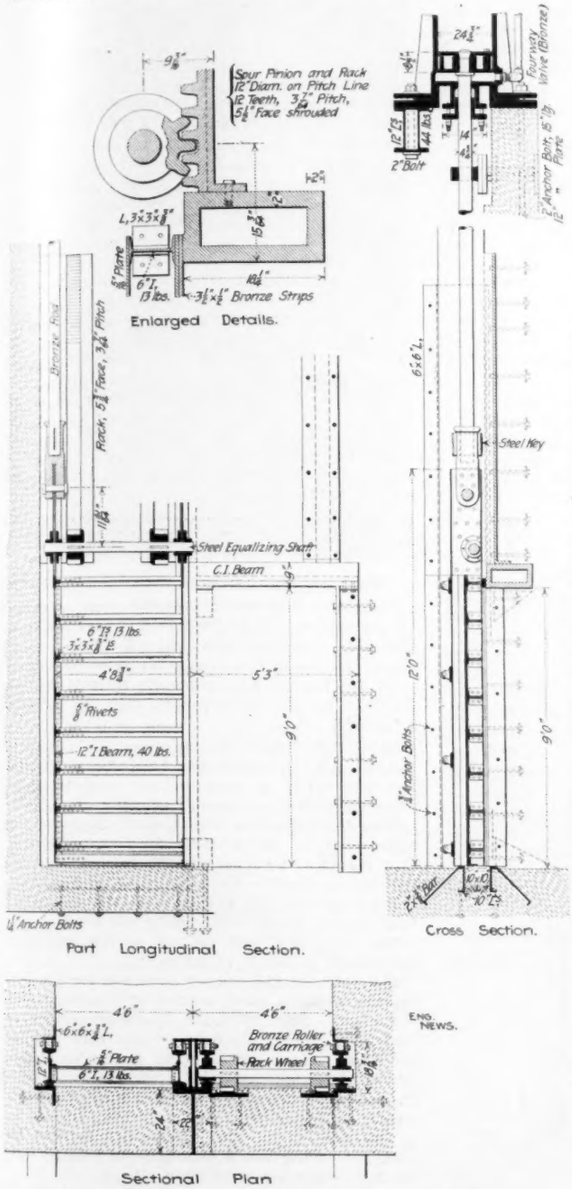

FIG. 7. HYDRAULIC GATES FOR DRAINAGE TUNNEL, KERN RIVER POWER PLANT NO. 1.

This flume takes the water as it flows over the wasteway from the forebay and conducts it back to the river, delivering it about 750 ft. upstream from the power house. (Fig. 1)

The steel tower transmission line (Fig. 2) is about 120 miles in length. There is a single line of towers designed to carry three circuits of 7-strand No. 0000 B. & S. gage copper cable. Two circuits are strung at the present time, a third one to be added when required.

The company secured a 100-ft. right-of-way for the whole distance, intending to erect another line of towers, when more power is developed on Kern River.*

The insulators used on the transmission line were of the upright petticoat type (Fig. 13), as the suspended disk type of insulator was not proven before construction commenced on this line. The steel towers (Fig. 2) were made by U. S. Windmill & Engine Co., Batavia, Ill.

The spans vary in length to suit the topography of the country. On the plain they are about 700 ft., unless varied on account of horizontal angles in the line, while in hilly and mountainous sections the towers are placed on high points to make the line span depressions. The longest span is 2,250 ft. between the main supporting towers, guided by an entirely unloaded tower at the bottom of the sag.

The transmission line terminates in the company's principal distributing station and auxiliary steam plant in Los Angeles, known as "Los Angeles No. 3." There are four step-down transformer banks of 4,500 KW. each with double taps on secondary side to 32,000 or 16,000 volts. In ordinary operation all current from Kern River No. 1 is handled through the double 16,000-volt bus. The steam installation in this station consists of two 2,000-KW. Curtis turbine alternators and one 6,000-KW. Westinghouse-Parsons turbo alternator. The steam supply is obtained from eight 500-HP., and seven 750-HP. Stirling boilers. The smaller boilers were designed for 125° superheat at the throttle and the larger ones for 150° superheat and 175 lbs. steam pressure. The plant, when operated as at present for carrying peak loads, carries a boiler pressure of 165 lbs.

TECHNICAL FEATURES OF THE DESIGN.

The following refers to the principles applied and conclusions reached in designing the works:

INTAKE.—The important problem connected with designing the intake was that of providing a channel which would admit sufficient water for filling the conduit, after it had reached a state of uniform flow. There are many examples of both pipes and canals, planned as gravity conduits, which are flowing full near their intakes, but only partly full lower down. These are the result of misapplying formulas for flow in pipes and other gravity conduits.

Such formulas express, as nearly as possible at the present state of hydraulic science, the relation of velocity to all the conditions inherent in open or closed channels; but none of them are constructed to provide allowances for accelerating water from a state of rest to one of velocity, or from one velocity to another. Therefore, when other principles of hydraulics are not applied to learn what allowances are necessary, a portion of the channel near the intake becomes a medium for accelerating a certain quantity of water to its normal velocity, which is never sufficient to fill the channel lower down.

To provide some means for accelerating the water to the normal velocity, for which it is intended to design a channel by the use of Kutter's formula, for instance, is equally as important as to apply the formula correctly to the channel itself. This may be done in two ways, depending on whether it is desired to keep the depth of water at the intake the same as that in the channel, or whether the width must be maintained the same and the depth varied.

In the present case, for reasons immaterial to this discussion, the first plan was adopted, and the channel for accelerating the flow was designed as follows:

Assuming depth and quantity of water constant and area and velocity as variable, the following formula was used to obtain the form of the channel required:

$$W_n = \frac{N_n}{N} W,$$

in which

W = normal width of conduit after velocity is accelerated, in feet.

N = number of any one of the sections into which the tapering channel is divided, counting from the intake.

N_n = number of sections into which the tapering channel is divided.

W_n = width of section N, in feet.

This is the equation of a rectangular hyperbola, of which both axes are asymptotes. A solution of the equation for the initial section, o, at the intake of the tapering channel, gives infinity, which represents the width of the reservoir from which the water, being at rest, is to be accelerated. A solution for any other section gives the theoretical width, which the beginning of that section must have to bring about an absolutely uniform and regular acceleration of the water.

In this way the form of the channel can be determined, after which the fall to be given in

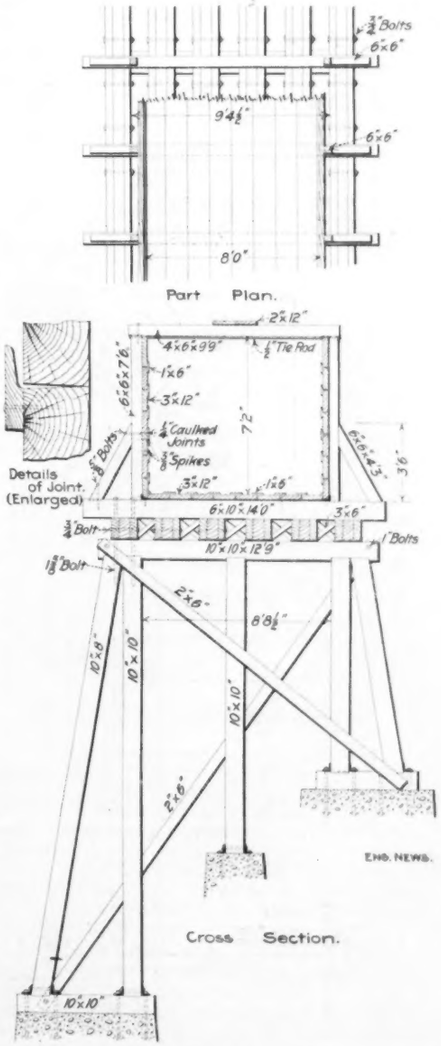

Fig. 8. Timber Flume, Kern River Power Plant.

*The Edison Electric Co. has water rights, contracts with the irrigators and government concessions for four power plants on Kern River above the present one. These will be known as Kern River Nos. 2, 3, 4 and 5, when they are constructed.

each section may be calculated by the following formula:

$$F = \frac{V_1^2 - V_0^2}{2g} - \frac{2L \times V_m^2}{C_m^2 \, r_m}, \text{ in which}$$

F = fall in feet for each section of the tapering channel.

V_0 = velocity, in feet per second, from which to accelerate.

V_1 = velocity, in feet per second, to which to accelerate.

This formula is rational, except as to the taking of 2 L instead of L. This change is due to the observed fact that the frictional loss in a tapering channel is twice that in a straight channel.

When applying these formulas in practice any length of tapering channel desired may be adopted, and this may be divided into any number of separate sections for the purpose of calculation. As the upper half becomes very wide, and, therefore, impracticable to construct, it is customary to use only the lower half, which will always have, at its inception, twice the width of the normal channel, after the velocity has become uniform and will, therefore, have half the velocity to be attained finally. The required velocity at this point is best obtained by raising the level of water in the pond, or reservoir, sufficiently to induce it. Then starting with this the second half of the tapering channel is designed by applying the formulas given.

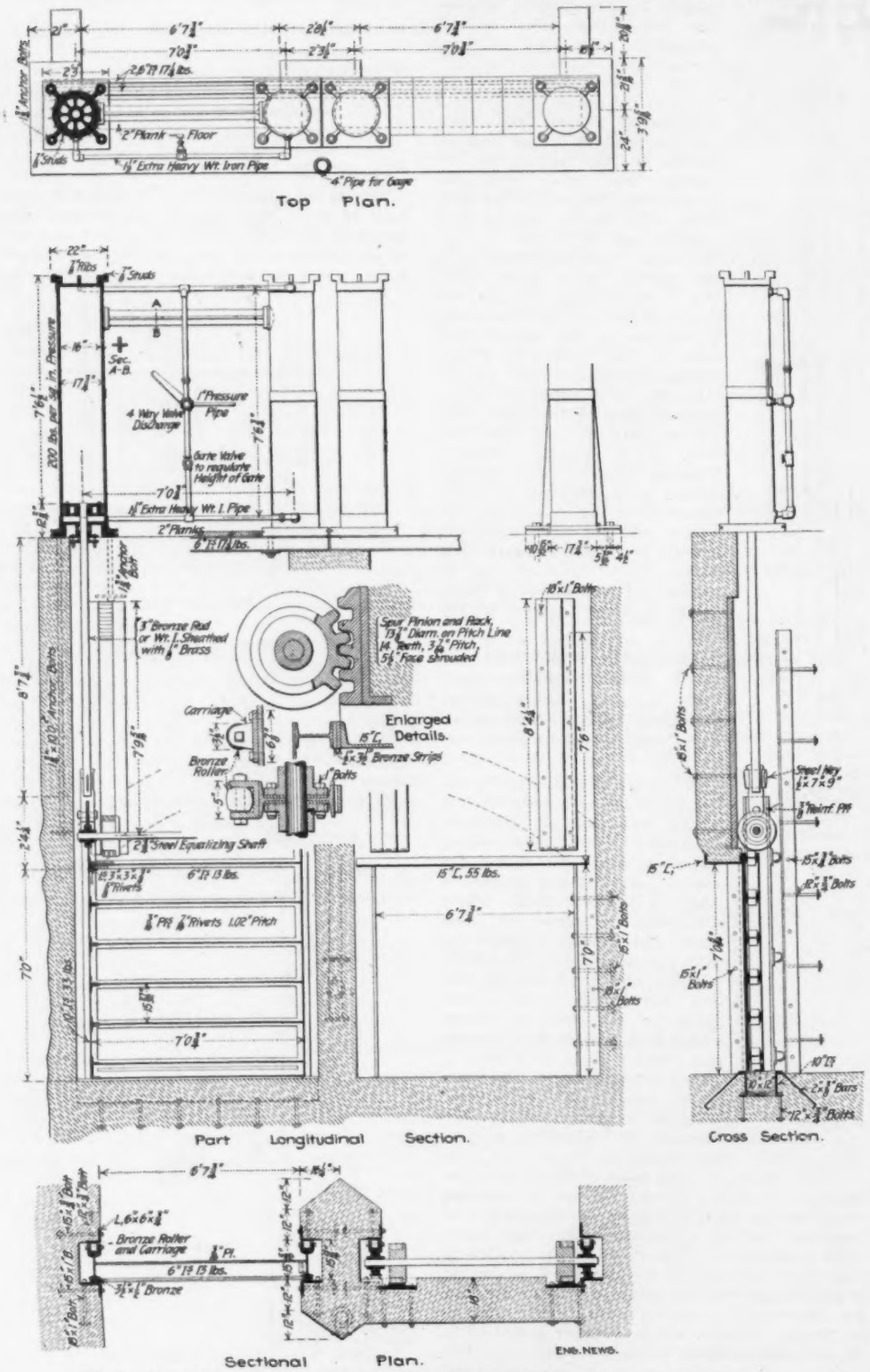

FIG. 9. HYDRAULIC GATES AT INTAKE, KERN RIVER POWER PLANT NO. 1.

C_m = mean coefficient, c in formula, $V = C\sqrt{rs}$, for section being considered.

r_m = mean hydraulic radius for section being considered.

L = length of each section in tapering channel, in feet.

g = acceleration of gravity.

v_m = mean velocity in section considered, in feet per second.

Fig. 14 is a reproduction of the designing sheet and diagram showing the practical application of these formulas, when designing the intake for Kern River No. 1, which has already been illustrated by Fig. 5.

In making the practical application in this case the intake channel was divided into eight sections. The upper half was eliminated by adding 0.32 ft. to the height of the diverting dam, which would produce 4.52 ft. per sec. velocity. The lower four sections are shown in the diagram, having an aggregate length of 50 ft. At the lower end of this tapering channel, the width of 8 ft., and velocity of 9.04 ft. per sec. have been attained, which is the normal condition of uniform flow from that point to the forebay, a distance of 44,894.7 ft.

The only other problem remaining was the adjustment of the dam to such an elevation as to provide head for overcoming the loss due to the grizzley, for screening the water. Experiments made with a temporary screen showed that 0.5 ft. would be lost in this way.

It was then figured that the obstruction caused by the central pier for the gate frame would require 0.18 ft. to overcome it. The elevation of the sill at the beginning of the tapering channel having been fixed at 2,000.98 ft. above sea level, the elevation of the flow line for a 6.5 ft. depth would be 2,007.48 ft. at that point. To this was added the following for heads required to overcome losses and attain 4.52 ft. per sec. velocity at the entrance.

For loss in grizzley	0.50 ft.
For loss from gate pier	0.18
For head to accelerate water from zero to 4.52 ft. velocity	0.32
Total	1.00 ft.

From this it followed that the crest elevation of the dam should be 2,008.48 ft. above sea level and this elevation was adopted. Tests made since the plant was put into operation show that the results were correctly foretold by the calculations, as the error is only 6% on the safe side.

GRAVITY CONDUIT.—In planning the gravity conduit, which has already been shown to consist principally of concrete-lined tunnels, there were no difficult problems requiring attention.

Considered from a commercial standpoint, it appeared from the investigations that the conduit should be given as small a section and high velocity as possible for a cemented surface. This conclusion was reached because the saving in head for the power plant would not produce sufficient revenue to pay interest on the additional investment required to make it.

The plan for the tunnels provided for plastering the water-carrying section with cement mortar of one part hydraulic Portland cement to two parts sand by measure. The safe velocity for water, which carries small quantities of fine silt at times, against such a surface is about 9 ft. per sec. A velocity much higher than this would gradually wear the surface, particularly in the bottom, till the roughness produced by such a wearing would decrease the velocity until this would arrest farther pitting.

The result of such a condition would be to decrease the capacity of the conduit and make possible the loss of water through fissures under the tunnel lining. From several similar tunnels, previously constructed by The Edison Electric Co. for its other power plants, it was known that the coefficient of roughness in Kutter's formula would be 0.012 for this conduit, as the short sections of flume of planed redwood also give $n = 0.012$.

The solution by Kutter's formula gave the grade required to carry 470 sec.-ft. of water in a channel 8 ft. wide running 6½ ft. deep, as 7.92 ft. per mile. The entire conduit from the end of the tapered intake channel was constructed on this grade.

Since turning water into the conduit tests have been made with a Price electric current meter, carefully calibrated for the occasion. The result of eight sets of such tests are as follows:

For depths of 3 ft. or less, the mean of all the tests gave a mean velocity of 1.3% less than that calculated by Kutter's formula with $n = 0.012$. For a depth of 4 ft. the mean of all the obser-

vations gave a mean velocity 0.4% higher than that calculated as above. For a depth of 6.5 ft., or full conduit, the mean of eight separate observations gave a mean velocity 2.3% higher than that calculated.

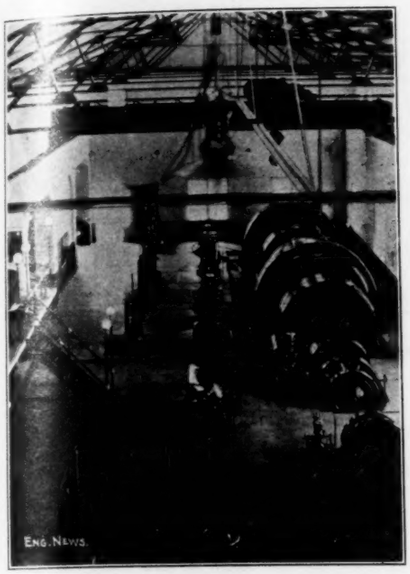

Fig. 10. Interior View, Showing Half of Kern River Power House.

WASTE FLUME.—In designing the waste flume two very unusual problems in hydraulic engineering were presented. These arose from the fact that in a flume on such a slope and 20 ft. wide, carrying a very shallow depth of water, the velocity does not follow the empirical formula of Kutter, nor any other such formula for flow in conduits, and further because it was necessary to make a horizontal curve in the flume line.

The first problem was that of finding the depth of flume required to carry the water, the width having been fixed at 20 ft. Kutter's formula, with others for the same purpose, does not apply, because of the formation of "standing waves" in flumes constructed on such steep slopes. In such cases these formulas give discharges greatly too large, and if applied to determine the depth of such a channel the result would be erroneous; the channel would be too shallow and the water would splash over its sides at every wave.

The waves formed in such channels are due to the same causes which produce the so-called "standing wave" when a plank is placed across a channel at the bottom, forcing the water to flow over it and thus creating a backwater upstream. In such cases the depth immediately above and at the "standing wave" is increased and the velocity is decreased, while below it the reverse again occurs.

Representing the depth of water by d, we have above the wave $v^2 > gd$, and below it $v^2 < gd$. Therefore, at some point between these two conditions, where $v^2 = gd$, the condition necessary to produce a standing wave occurs.

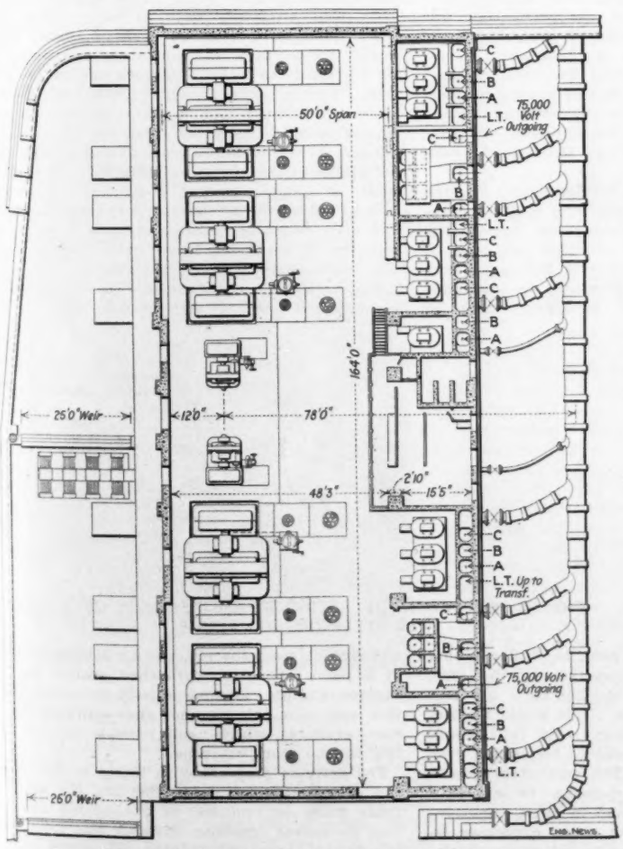

FIG. 11. PLAN OF KERN RIVER POWER HOUSE.

An acceleration of the velocity occurs in channels on very steep slopes until $d < \frac{v^2}{g}$, which continues to a point, where the frictional resistances on the bottom, resulting from the increase in velocity, become so great as to reduce v and increase d, until $d = \frac{v^2}{g}$, which is the condition required for producing a standing wave in these channels. Thereafter the wave, having reduced the velocity until $d > \frac{v^2}{g}$, it again begins to accelerate until another wave forms, etc.

Thus, in channels of this kind, a succession of waves will occur, which are nothing but momentary "standing waves." In the Kern River waste flume the condition was still further aggravated by the necessity of making frequent changes in the grade to conform to the slope of the very steep and irregular side of the mountain, down which the the flume passes. When a dimunition of slope is made, a reduction of velocity takes place until $v^2 = gd$, and a standing wave occurs.

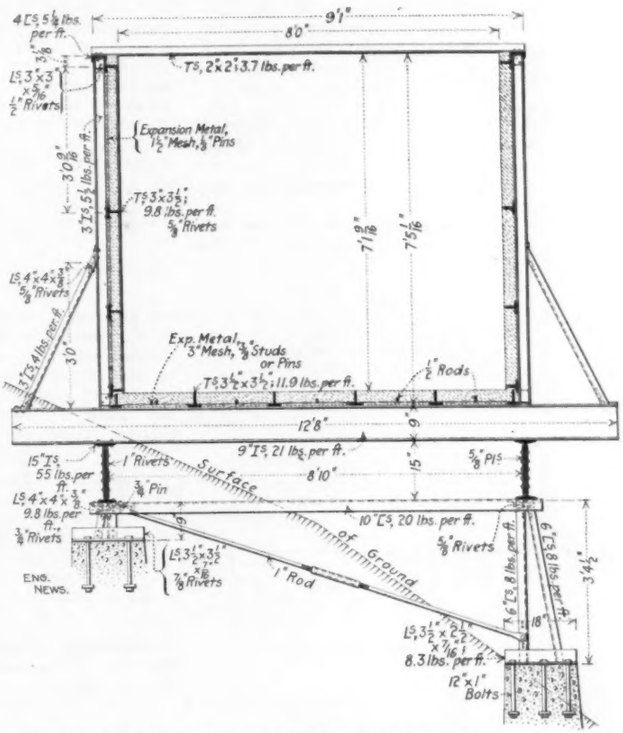

FIG. 12. CROSS-SECTION OF STEEL AND REINFORCED CONCRETE FLUME, KERN RIVER POWER PLANT.

The solution adopted for ascertaining at what points in this flume standing waves would occur was as follows: We have seen that immediately above such a wave $d < \frac{v^2}{g}$; inversely $v^2 > gd$, and from this expression the slope necessary to produce waves in a channel can be calculated by substituting for v^2 its equivalent in the Chezy formula, $v = C\sqrt{r\,s}$.

For this purpose it is necessary to assume that the depth and mean hydraulic radius of the channel are the same. Since the standing wave phenomenon can only occur in channels on very steep slopes, the water in such channels will also be shallow in proportion to their width, and the assumption that d and r are equal introduces no appreciable error. Hence $v = c\sqrt{ds}$ and $v^2 = c^2\,ds$. Substituting this value of v^2 in $v^2 > dg$, $c^2\,ds > gd$, or $c^2\,s > g$. Whence $s > \frac{g}{c^2}$, c being found by Kutter's formula.

From this expression it was possible to determine that waves would occur in the Kern River waste flume, as it was proposed, and where in the flume they must be expected. The problem then was to determine the approximate depth of water at the crest of these waves.

Representing the depth of water at the crest of the wave by D and the velocity by V, the problem becomes that of finding the value of D in terms of d and v. The velocity V, is less than above the wave, which is due to the loss of head caused by friction in the channel between the two points, by impact due to the increased sectional area of the stream and by loss of energy required to raise the whole body of water the distance $\frac{D-d}{2}$.

The head lost in these ways is $\frac{v^2}{2g} - \frac{V^2}{2g}$. If the insignificant loss of head due to friction between the two points be neglected we obtain

the equation $\frac{v^2 - V^2}{2g} = \frac{(v-V)^2}{2g} + \frac{D-d}{2}$. But $V\,D = vd$, whence $V = \frac{vd}{D}$.

Inserting this value of V in the above equation for lost head, reducing and solving for D, we have: $D = 2\sqrt{d\,\frac{v^2}{2g}}$. The calculations were made with velocities expressed in feet per second and the depths of water in feet. To the

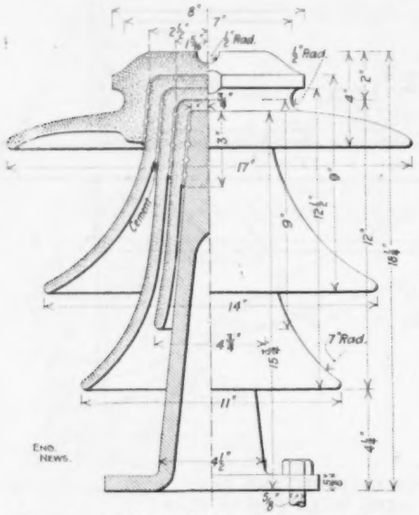

Fig. 13. Insulators Used on Kern River Power Plant Transmission Line.

value of D for any point in the flume was added the amount, which was deemed necessary to prevent splashing over the sides, and the sum gave the required depth of the flume at that point.

As the height of the waves varies greatly with the quantity of water in the flume, it was necessary to calculate it for all possible conditions from a minimum to 470 sec. ft., before the greatest value of D was learned.

The other problem on this flume was to find the height to which the water in it would rise

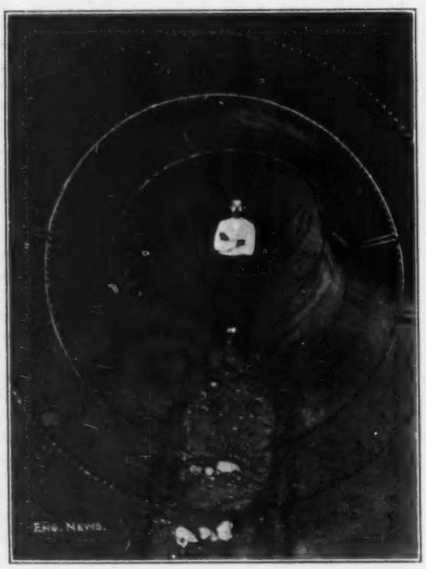

Fig. 16. Interior View of 75-Ft. Steel Lining for Supply Tunnel, Kern River Power Plant.

on the outside of a horizontal curve, which was required in the alinement. The solution was made as follows:

The surface of the water flowing in a curved flume assumes the form of a parabolic curve, $C\,D\,I$, as shown in Fig. 15. Assuming any elementary film D of water in the given cross section, whose angular velocity is v, weight w and distance $B\,D$ from the vertical axis $B\,H$, passing through the center of the circle formed by the curve y, its centrifugal force P is expressed as follows:

$$P = \frac{w}{g} v^2\, y, \text{ from which}$$

the angle ϕ ($F\,D\,G$ or $H\,B\,D$), formed by the resultant with the vertical, or the tangent $D\,H$ to the surface of the water at the point D with the horizon, can be expressed:

$$\tan \phi = \frac{v^2\, y}{g}.$$

Then at the point D, $\frac{dx}{dy} = \tan \phi = \frac{v^2\, y}{g}$.

Integrating gives the equation of the curve $C\,D\,I$, as follows:

$$y^2 = 2\,\frac{g}{v^2}\,x,$$

which is the equation of a parabola with $\frac{g}{v^2}$ for its parameter.

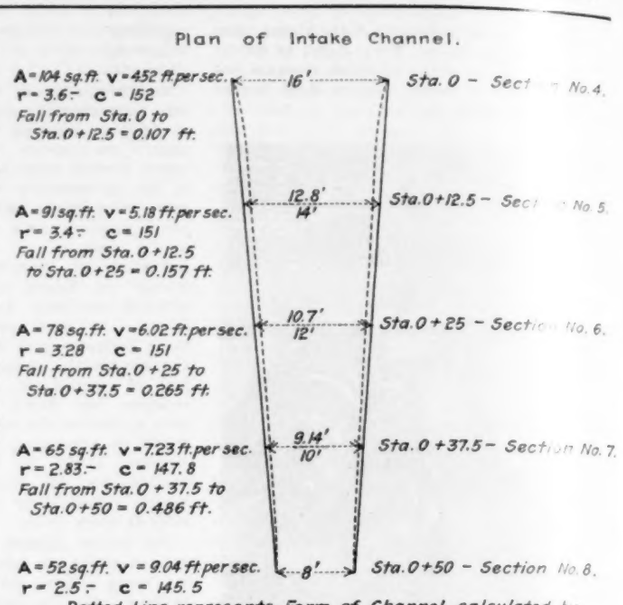
Plan of Intake Channel.
A=104 sq.ft. v=4.52 ft.per sec.
r=3.6 c=152
Fall from Sta.0 to Sta.0+12.5 = 0.107 ft.
16'
Sta.0 - Section No.4.
A=91 sq.ft. v=5.18 ft.per sec.
r=3.4 c=151
Fall from Sta.0+12.5 to Sta.0+25 = 0.157 ft.
12.8'
14'
Sta.0+12.5 - Section No.5.
A=78 sq.ft. v=6.02 ft.per sec.
r=3.28 c=151
Fall from Sta.0+25 to Sta.0+37.5 = 0.265 ft.
10.7'
12'
Sta.0+25 - Section No.6.
A=65 sq.ft. v=7.23 ft.per sec.
r=2.83 c=147.8
Fall from Sta.0+37.5 to Sta.0+50 = 0.486 ft.
9.14'
10'
Sta.0+37.5 - Section No.7.
A=52 sq.ft. v=9.04 ft.per sec.
r=2.5 c=145.5
8'
Sta.0+50 - Section No.8.
Dotted Line represents Form of Channel calculated by Formula : $W_n = \frac{N_n}{N} W$.
Solid Line represents Form of Channel adopted as practicable.
Upper Figures, where two are given for width at one Point, represent width by Formula : $W_n = \frac{N_n}{N} W$, and Lower Figures represent width adopted for practical purposes.
Depth of Water to be uniform at 6.5 ft.
Coefficient of Roughness, n, in Kutter's Formula = 0.012
Total Fall in Intake Section is 1.015 ft.

FIG. 14. CALCULATION FOR THE INTAKE CHANNEL, KERN RIVER POWER PLANT.

This general equation was used and the form of the water surface in the flume at the curve calculated. The result of the calculation was used to determine the height of the side for the flume around the outside of the curve.

Tests made since the plant has been in operation have showed that the conclusions reached, both as to height of waves and elevation of water outside of curve, are conservative, and that the calculations are proved by the actual results obtained.

FORCE MAIN.—After determining, in the usual manner, that a single pipe of 90 ins. internal diameter, or several pipes having the same capacity, should be provided, the type of construction to be adopted was thoroughly analyzed. It was deemed necessary to place underground whatever pipe, or pipes, might be selected, because the formation of the mountain was very loose and unstable on the surface, and on account of the great variations in temperature. The loose surface would not only make it difficult to anchor the pipe safely, but would leave it exposed to blows from rolling rocks, if it were left unprotected. The extremes of temperature, ranging from 160° F., in the blazing summer sun to 15° F., above zero, in winter, would cause expansion and contraction in the steel pipes, which would both shorten their life and cause more or less leakage. This would be true even if the pipes were always kept full of water, but particularly true should the water ever have to be turned out. The estimates showed that it would be very expensive to excavate trenches on such a slope and in loose, treacherous, seamy rock, and still more expensive to backfill the trenches, so as to retain the backfill and prevent it from sliding down hill.

After investigating the engineering problems involved to find a better type of construction than that ordinarily used in such cases, the novel plan of driving an inclined tunnel deep below the surface, in solid rock, and lining it on the inside to make it smooth and impervious was adopted. The principal problems involved were to construct such a tunnel in the time required to finish the other work on the plant, to render it safe against the internal strains resulting from the high head (879 ft. at the lower end), to prevent loss of water by percolation, and to render the lining on the inclined shaft, or tunnel, sufficiently resistant against collapse on account of pressure, from water collecting in the formation outside of the tube.

The first of these difficulties was overcome by working the bore by stoping from the bottom

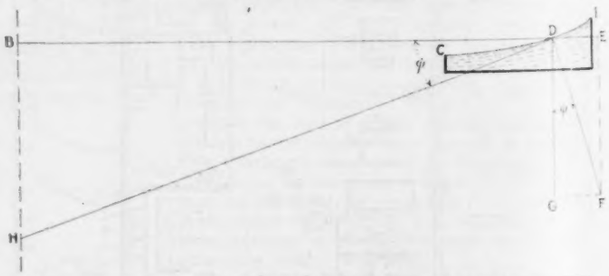

FIG. 15. SKETCH ILLUSTRATING STUDY OF FLOW OF WATER IN STEEP CURVED FLUME.

and sinking from the top, and by driving an adit at a point where it approached nearest to the surface, and also working in both directions from this adit. In this manner four working faces were available, which made possible the completion of the work on time.

The extreme pressure on a lining at the lower end of the tube would be 380 lbs. per sq. in. Tests made of concrete on the ground showed that its lowest crushing strength was 1,296 lbs. per sq. in., when six months old, which would give concrete at least a safety factor of four,

where the pressure is greatest. The same concrete when tested for percolation showed that up to 75 lbs. per sq. in. the leakage through a block 12 ins. thick was very slight, but as the pressure rose above this the leakage increased rapidly.

The concrete subjected to these tests was made by the void method of fixing proportions: 10% more cement added to the sand than its total voids and 20% more of this mortar added to the crushed rock than its total voids.

These lining tubes were made up into 10-ft. sections in the pipe yard, riveted together into a continuous tube in the tunnel, before placing

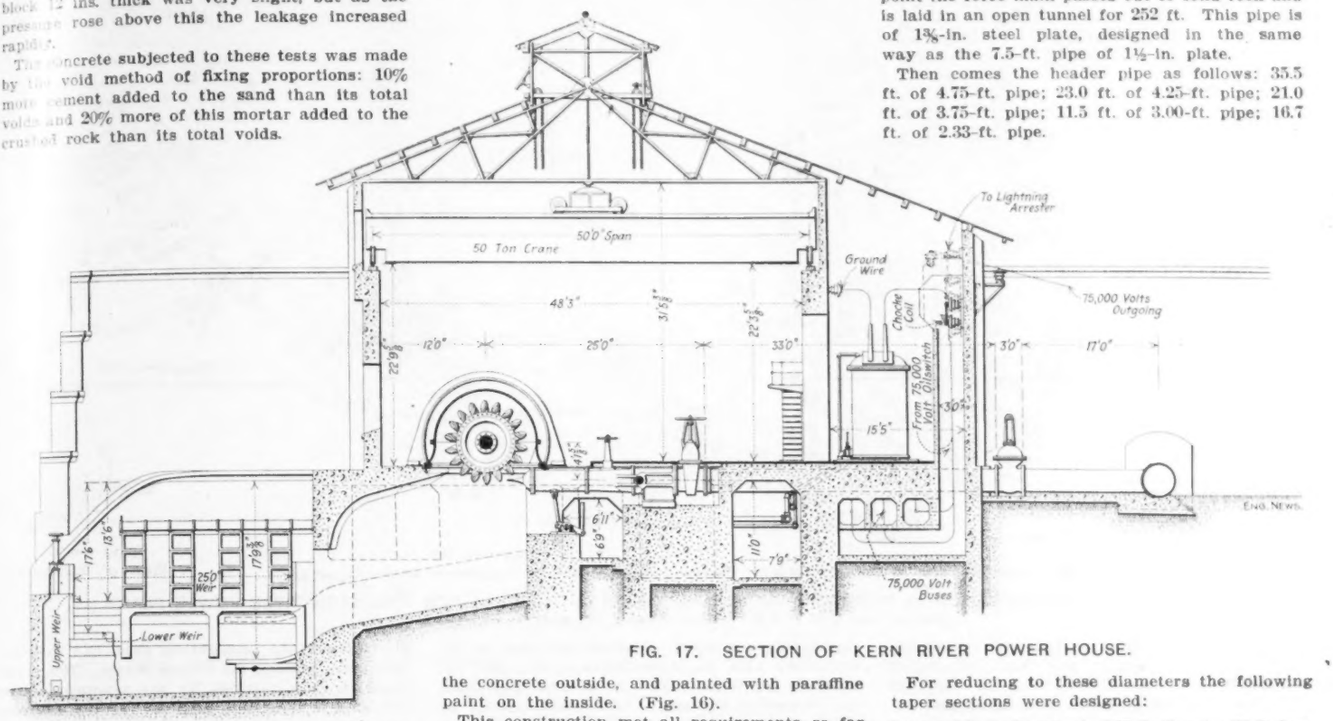

FIG. 17. SECTION OF KERN RIVER POWER HOUSE.

the concrete outside, and painted with paraffine paint on the inside. (Fig. 16).

From the results of these tests it was concluded that concrete, if used as a lining for the pressure tunnel, would be safe against crushing, but not against percolation. It was, therefore, decided to use a steel tube 7.5 ft. inside diameter, made of 3/16-in. steel plate and single riveted for the inside lining, and to fill the space between the outside of this and the rock sides

Fig. 18. Rotor of Impulse Turbine for Generator Set, Kern River Power House.

of the tunnel with concrete. The thickness of 3/16-in. was selected solely to give the section the necessary rigidity for handling them while making the installation. They were not calculated to resist the hydraulic pressure, which is transmitted to the concrete and natural rock behind the steel.

This construction met all requirements so far as ability to resist internal pressure and prevent percolation was concerned, but calculations showed that, if water should collect between the concrete and the steel tube, and the force main be emptied at any such time, the external pressure would collapse the thin steel lining, or rupture it in a sufficient number of places to relieve the pressure by discharging the accumulated water. To forestall failure from such a cause, a 2-in. drain tube of standard screw pipe was burried in the concrete on each side and outside of the steel lining tube. Openings into this drain were made at 20-ft. intervals by inserting tees, which were turned towards the outside of the steel lining and close to it, so as to prevent concrete from entering when filling around it.

Where the adit was made for expediting the work, it became necessary to install a section of pipe sufficiently heavy to resist the pressure, as there was no rock to contain the cement concrete lining. This was figured at 7.5 ft. inside diameter, with double longitudinal and single circular butt straps, and required the use of 1⅛-in. steel plate, 1⅛-in. rivets in 1 3/16-in. drilled holes with 8-in. pitch. The factor of safety adopted in designing this section of the work was five, based on 60,000 lbs. as the tensile strength of the steel and 15% loss on account of the riveted joints.

The calculations for strength of joints were made as follows:

$8 \times 1\frac{1}{8} \times 60{,}000 = 720{,}000$ lbs. for solid plate.
$6\ 13/16 \times 1\frac{1}{8} \times 60{,}000 = 613{,}125$ lbs. for drilled plate.
$1.1075 \times 13 \times 42{,}000 = 604{,}695$ lbs. for rivets.

$$\frac{613{,}125}{720{,}000} = 85\frac{1}{4}\% \text{ for the plate.}$$

$$\frac{604{,}695}{720{,}000} = 84\% \text{ for the rivets.}$$

These lining tubes were made up into 10-ft. sections in the pipe yard, riveted together into a continuous tube in the tunnel, before placing

At the lower end of the 7.5-ft. tube a taper reducing the diameter to 5.25 ft. was placed in a concrete bulkhead in solid rock. From this point the force main passes out of solid rock and is laid in an open tunnel for 252 ft. This pipe is of 1⅜-in. steel plate, designed in the same way as the 7.5-ft. pipe of 1⅛-in. plate.

Then comes the header pipe as follows: 35.5 ft. of 4.75-ft. pipe; 23.0 ft. of 4.25-ft. pipe; 21.0 ft. of 3.75-ft. pipe; 11.5 ft. of 3.00-ft. pipe; 16.7 ft. of 2.33-ft. pipe.

For reducing to these diameters the following taper sections were designed:

1	taper	7.5	ft.	diameter	to	5.25	ft.	diameter	20 ft. long.
1	"	5.25	"	"	"	4.75	"	"	10 " "
1	"	4.75	"	"	"	4.25	"	"	10 " "
1	"	4.25	"	"	"	3.75	"	"	10 " "
1	"	3.75	"	"	"	3.00	"	"	10 " "
1	"	3.00	"	"	"	2.33	"	"	10 " "

The branches to each of the generator impulse turbines are 2.33 ft. diameter, eight in number, with one extra for blow-off and experimental testing of nozzles. There are two 10-in. branches to the exciter turbines.

The Risdon Iron Works, of San Francisco, installed all of the steel work and the 28 and 10-in. gate valves under contract, according to plans and specifications furnished by the Edison Co.

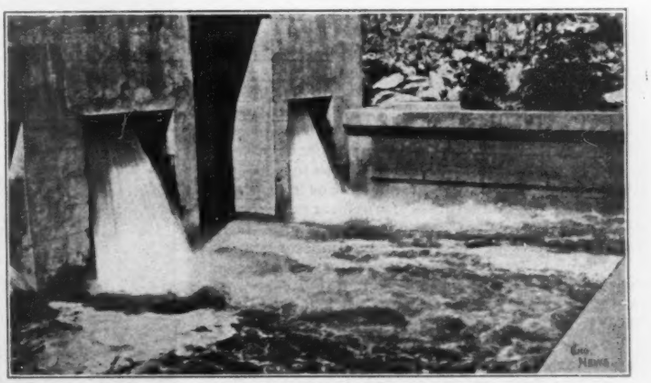

FIG. 19 PORTION OF TAIL RACE, KERN RIVER POWER PLANT, SHOWING DISCHARGE OF WATER FROM DEFLECTOR PLATES WITH JET PARTLY DEFLECTED FROM BUCKETS.

When tested this work showed no defects and none have developed under actual operation for one year.

HYDRAULIC TURBINES.—The two problems involved in the design of the hydraulic turbines, which are interesting from a technical standpoint, were efficiency and regulation. In the installation of all previous hydro-electric plants the Edison Co. permitted the manufacturers and their engineers, without technical supervision or restraint from the company's engineers, to design and manufacture such hydraulic generating equipment as they were willing to guarantee.

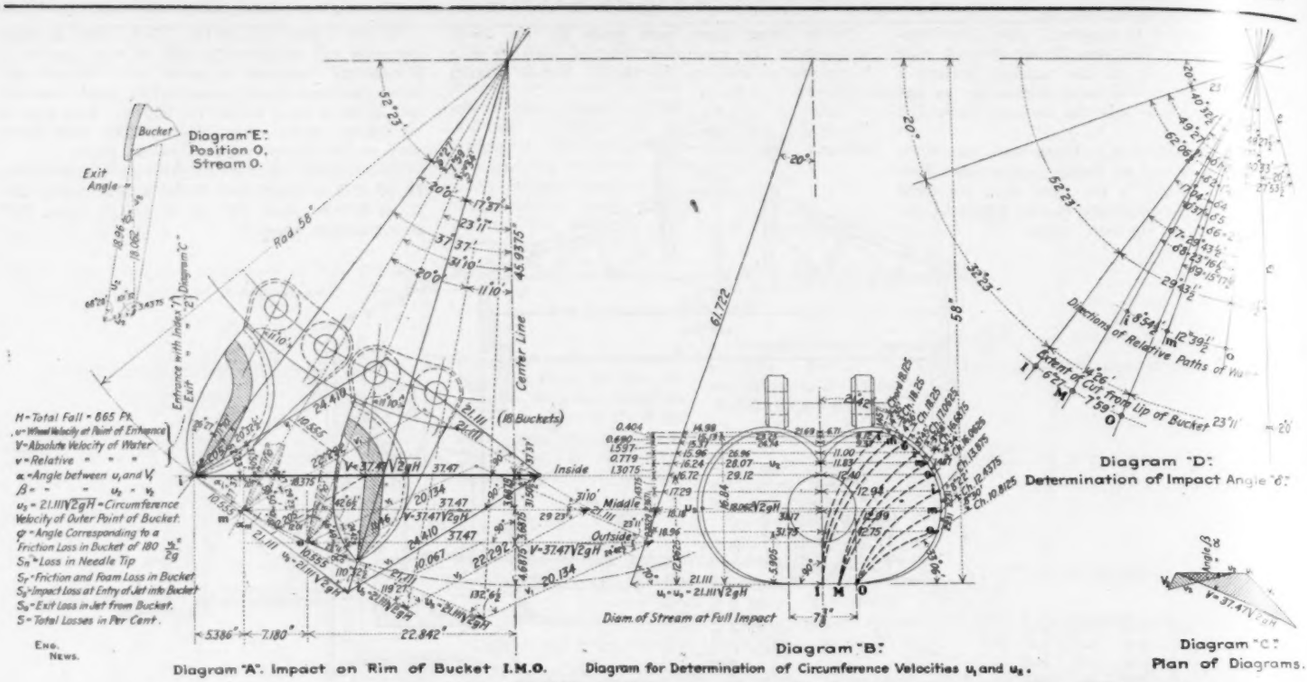

FIG. 20. DIAGRAMS USED IN DESIGNING BUCKETS OF IMPULSE TURBINES FOR THE KERN RIVER POWER PLANT.
(Scale of cut, ¾-in. = 1 ft. Original drawing was made on scale 3 ins. = 1 ft.)

This practice had also been followed by the Edison Co.'s predecessors, who had constructed some of its plants as far back as 1892. The only exceptions to this practice were occasional objections from the company regarding the size of connecting pipes and gates for conducting the water to the wheels, when these were proposed on a wrong basis.

Knowledge gained by the company in operating half a dozen plants constructed with turbine equipment furnished by contractors in this manner revealed many defects. The efficiencies obtained were rarely up to the guarantee, and never up to the results which should have been secured with proper designs. This fact was due either to the construction of the wheels with excessive specific speeds, or erroneous design of the buckets. [Specific speed is used in this article to mean the speed of a runner of 1-ft. diameter under 1-ft. head.—Ed.] The latter trouble was the most frequent and acute cause of low turbine efficiency, as is shown by the manner in which buckets were eroded.

The fundamental requirements for good regulation were never observed, with the result that, no matter how good governors were employed, the regulation obtained was unsatisfactory.

When water wheel equipment was needed for Kern River No. 1, the first step was to ask for bids from manufacturers furnishing their own designs. Responses were received both from manufacturers of reaction and impulse turbines. The former were quickly eliminated, as reaction turbines were not considered suitable for units of 10,750 B. HP. operating under a net head of 865 ft.

Of designs for impulse turbines there was a great variety, but all of them were open to grave objections from an engineering standpoint. One well-known manufacturer offered a 10,750 B. HP. rotor at 250 r. p. m., for which a 10-in. nozzle was required and the buckets were over 40 ins. wide.

It was evident that the specific speed for such a unit was in excess of anything which would yield even a fair efficiency, to say nothing about excessive losses from windage and the use of so large a jet. Other manufacturers offered 10,750 B. HP. units with two rotors each, and buckets and nozzles of reasonable dimensions, but speeds of 350 and 400 r. p. m. The shape of all buckets offered was open to criticism, not only on theoretical grounds, but from results observable where similar designs have been used.

Under this state of affairs the company could do nothing but reject all offers and take up negotiations with the Allis-Chalmers Co., who offered to build the turbines, nozzles, governors, etc., according to designs to be made jointly by their engineers and the Edison Co.'s engineers. A contract was closed along these lines and the engineers of both companies participated in and agreed to all designs adopted.

This resulted in the production of buckets, nozzles and governors of a more perfect type for the Kern River installation, than had ever before been made in the United States. This statement is fully justified by the practical results obtained in operation both as regards efficiency and absence of wear on buckets, needles and nozzles. In fact, it may be stated that the results arrived at by calculations and embodied in the plans, have been fully attested as correct by actual tests of the entire equipment, since operating the plant.

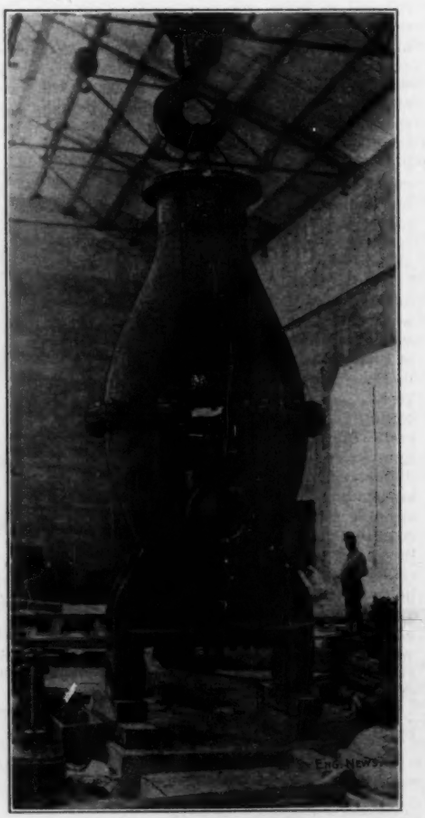

Fig. 21. Bifurcated Nozzle Casting, Kern River Power Plant.

It would require a good-sized volume to cover the details relating to the design of these turbines, but there are a few general phases of the subject which it is interesting to mention.

The final conclusion reached was to adopt a speed of 250 r. p. m. and 10,750 B. HP. in two runners, for each unit as the maximum capacity. This would require each runner to develop the following power, under various conditions of operating the electrical generators:

	B. HP.
At normal load	3,580
At 25% overload	4,475
At 50% overload	5,375

If n represents the speed in r. p. m., N the number of brake horse-power for each runner, H the head in feet and n_s the specific speed, or speed of a runner of 1-ft. diameter under 1-ft. head, we have the following equation:

$$n_s = \frac{n}{H}\sqrt{\frac{N}{\sqrt{H}}},$$

from which the following specific speeds were calculated:

For normal load	3,192
For 25% overload	3,569
For 50% overload	3,912

According to *Baashuus these specific speeds would give the following efficiencies:

	Per ct.
At normal load	77
At 25% overload	76½
At 50% overload	76

But the conclusions of Baashuus are based on tests with impulse turbines, which had buckets and nozzles designed without special regard to obtaining the highest possible efficiencies. They were, in fact, deductions made from the conditions presented by the majority of impulse plants somewhat carelessly designed.

If we take the highest types of impulse turbine installations, such as are represented by that at Innsbruck in Europe and the Pelton unit at Mill Creek No. 3 in this country, the law of

*See "Electrotechnischen Zeitschrift," Berlin, for 1905, p. 961.

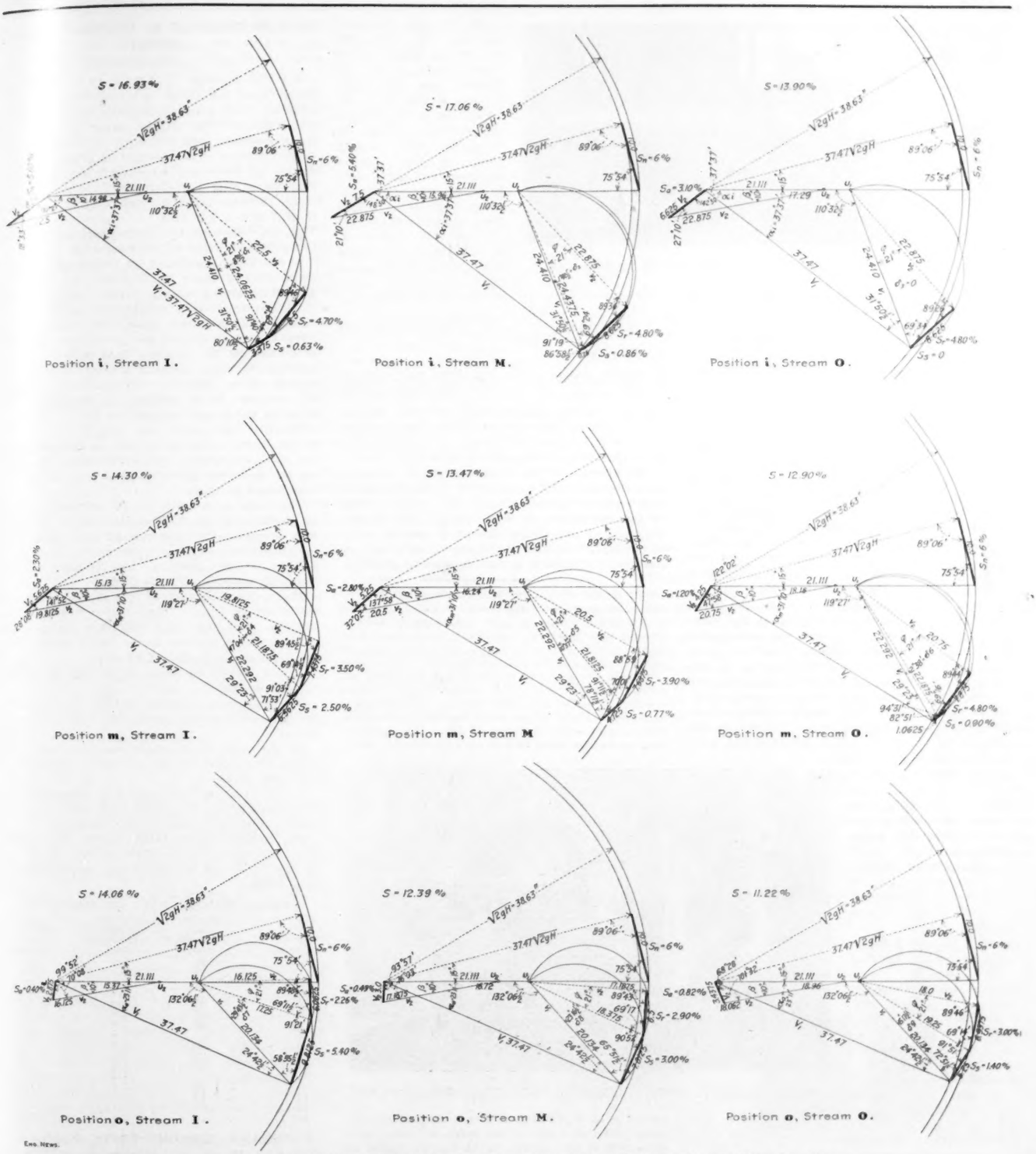
Position i, Stream I.
Position i, Stream M.
Position i, Stream O.
Position m, Stream I.
Position m, Stream M
Position m, Stream O.
Position o, Stream I.
Position o, Stream M.
Position o, Stream O.

FIG. 22. GRAPHICAL DETERMINATION OF LOSSES OF ENERGY FOR VARIOUS POSITIONS.
(Original drawing was made on same scale as Fig. 20.)

relation between specific speed and efficiency, as laid down by Baashuus, still prevails, but the possible efficiencies are increased about 5%. On this basis the possible efficiencies to be obtained at Kern River No. 1, as judged by the specific speeds adopted, would be as follows:

Load.	Specific speed.	Efficiency, per cent.
Normal	3,192	82
25% overload	3,569	81½
50% overload	3,912	81

The design of the buckets was made as shown on the diagram prepared for that purpose (Fig. 20, which gives results indicating slightly higher efficiencies than these. The Allis-Chalmers Co. took a middle ground, guaranteeing 82½% efficiency at normal load. Tests sufficiently accurate to determine whether the efficiencies indicated on Fig. 20 have been obtained or not, have not been made, but it is certain that those given as calculated from the specific speeds (81 to 82%) have been attained.

Improvements in the buckets were not the only ones which contributed to secure so high efficiencies with such comparatively high specific speeds, but the nozzle and needles were also improved greatly over former practices. The nozzle casting is bifurcated to permit of bringing the needle stem out without offsetting the nozzle, and thus throwing a side-strain on the ball joint bearings and causing eddies, which tend to disfigure the jet (Fig. 21).

The needle for adjusting the size of the jet has a stem equal in diameter up to the point where it reduces to conform with the nozzle tip (Fig. 23). In this way it differs from former designs having a slender stem with a bulb at the end, which again reduces to a point at the nozzle tip. The advantages secured by the thick stem of uniform diameter (Fig. 23) are that it obviates the reverse curvature of the filaments of water, which takes place with a bulb nozzle, and gives rigidity preventing the lateral deflec-

FIG. 23. TYPE OF NEEDLE USED IN KERN RIVER POWER PLANT.

tion of the needle, which occurs in offset nozzles with slender needle stems and bulb or plumb bob point. The needles are hydraulically balanced, running back into a balancing chamber supplied with water from the pressure side.

The buckets, of which there are 18 to each runner, are 27⅛ ins. wide and cast of special bronze and polished to a template made from the detail drawing (Fig. 24).

The problem of regulation was given very minute attention in designing both the generator and exciter units. This was quite an important matter to the Edison Co., because its other six hydraulic plants all varied in respect to regulating ability. As already explained, the manufacturers who designed and furnished the equipment for these plants did not so design their machinery as to make good regulation possible, although Lombard hydraulic governors, which are entirely reliable, were used.

It was deemed necessary to make the Kern River plant the regulating station of the company, as this would overcome the deficiencies in all other plants, and give uniform and satisfactory regulation for the entire system. It was decided to so design the electrical and hydraulic generating equipment as to secure a speed variation of about 5% for 100% load variations, when operating at rated normal load. This would give 6.25% speed variation at 25% overload and 7.5% at 50% overload for 100% instantaneous changes in load.

For determining the moment of inertia necessary to give this regulation let,

E = the kinetic energy necessary to be stored in fly-wheel effect.
M = the mass.
v_1 = the angular velocity at normal speed of turbine.
v_2 = the angular velocity after a 100% sudden load variation.
W = the weight of revolving elements of the unit.
R = the radius of gyration of revolving elements.
N = the brake horse-power of turbine.
r = revolutions per minute.
T = time in seconds for deflecting nozzle, and
δ = percentage of speed regulation.

Then,

$$E = \frac{M}{2}\left(v_2^2 - v_1^2\right),$$

$$v_2 = v_1\,(1 - \delta),$$

$$\frac{550\,N\,T}{2} = \frac{W}{2g}\left[v_1^2\left(1-\delta\right)^2 - v_1^2\right],$$

$$\frac{550\,N\,T}{2} = \frac{W}{2g}\,2\delta\,\frac{4\,\pi^2\,R^2\,r^2}{60^2}, \text{ and}$$

$$\Sigma\,W\,R^2 = 800{,}000\,\frac{N\,T}{\delta\,r^2}$$

By solving the last equation for the conditions at hand it was found that about 1,800,000 lbs. at 1 ft. radius would give the regulation demanded for the generator units. In designing the rotating parts of the impulse turbines and generators $\Sigma\,W\,R^2$ was, therefore, made 1,800,000, which was accomplished by increasing the weight of the rim in the revolving field spider of the generator.

Using this value and solving the equation, $\delta = 800{,}000\,\dfrac{N\,T}{r^2\,\Sigma\,W\,R^2}$, we obtain the following values of δ:

At normal load	5.09% speed variation.
At 25% overload	6.36% speed variation.
At 50% overload	7.64% speed variation.

These are the performances for 100% instantaneous changes of load with the Escher-Wyss type of governors, which are set to deflect or raise the nozzle in one second of time.

The above has not been written to supply a complete guide to be followed in the design of hydro-electric power plants, but to show some of the improvements made possible by investigations and experience extending over a period of twenty years, and in the hope that it will assist young engineers in solving similar problems.

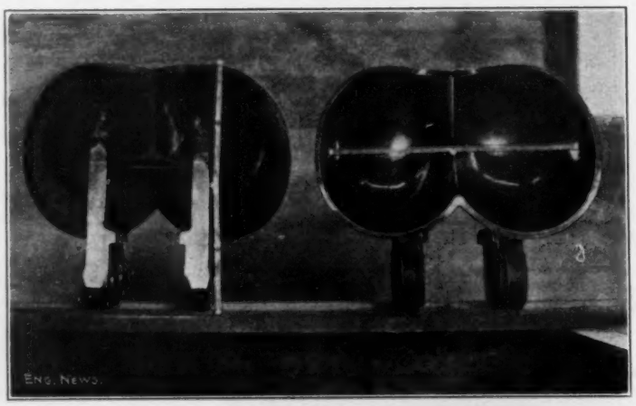

FIG. 24. BUCKETS FOR TURBINES OF KERN RIVER POWER PLANT.

THE ELASTIC LAG OF RUBBER was found to require special study in the course of experiments with models of dams, made by J. S. Wilson and W. Gore as reported in a paper read before the Institution of Civil Engineers ("Stresses in Dams: An Experimental Investigation by Means of India-Rubber Models"). The amount of the lag was measured by compression tests of a rectangular block of the rubber mixture used (a mixture considerably stiffer than pure rubber). On applying a load to this block, it was found that the distortion increased continuously for over 18 hrs. The immediate compression was about 90% of the final amount, and at the end of the first two hours 95% of the total had been reached; thereafter the increase was very gradual, up to about 18 to 24 hrs. Because of this lag, the loading applied in the model experiments was left on for 24 hrs. in each case before measuring the distortions, and after removing the load a period of 48 hrs. was allowed for the model to recover its original shape.

MINERAL RESOURCES OF OKLAHOMA are commented on as follows in a bulletin just issued by the Oklahoma Geological Survey (Charles N. Gould, Director, Norman, Okla.):

Few states have either as many kinds of mineral or as much mineral of a kind as has Oklahoma, but at the present time not 0.5% of it has been developed. The state has deposits, which for all practical purposes are inexhaustible, of the following valuable minerals: Coal, oil, gas, asphalt, gypsum, salt, lead, zinc, shale, clay, glass sand, granite, gabbro, limestone, sandstone, building sand, gravel, and Portland cement rock, besides smaller deposits of iron, copper, tripoli, novaculite, volcanic ash, and a little gold and silver.

So little has been done in the way of the development of the mineral resources of the state that no one can yet even estimate either their amount or their value.

TESTS ON THE EFFECT OF ELECTRIC CURRENT ON CONCRETE.

By U. JAMES NICHOLAS.*

For the purpose of adding to the very few data† upon the effect of electric current upon concrete, the writer undertook the experiments noted below. The original paper, of which this is an abstract, was presented to the Massachusetts Institute of Technology as a thesis for the degree of Electrical Engineer. The objective of this thesis was to determine:

(1) The insulating properties of the concrete, if any, and if not any.

(2) The effect of the electric current upon the concrete and its steel reinforcement.

It has been established by protracted test that even after a lapse of 20 years, sea water, a powerful rusting agent, cannot oxidize or rust steel imbedded in a non-porous concrete. Extended practical tests have been conducted by Prof. Charles L. Norton on the protection of steel from rusting by concrete from which he concludes: (1) Neat Portland cement, even in thin layers, is an effective preventive of rusting; (2) concrete to be effective in preventing rust must be dense and without cracks.

Whether the enveloping cement or concrete would exert a similar protective influence over the steel when both were subjected to the effect of an electrical potential, was the problem it was hoped to solve.

The tests were made on 16 cylindrical blocks of concrete, 8 ins. in diameter and 8 ins. high, of a standard Portland cement and coarse sand in proportions varying from neat cement to a 1:3 (by weight) mixture. The absolute voids in the sand were found to be 51%.

The mortar was tamped into the steel molds in 1½-in layers, until a little water flushed to the surface. The steel pipe was then inserted and the specimens allowed to set up in fresh water for a minimum period of 28 days.

It was decided to carry on the test in the following manner:

(1) To pass a constant current of 0.1 amps. through eight of the specimens—two from each group.

(2) To place four specimens, one from each group, in parallel across a constant potential of 115 volts, and

(3) To save the remaining four specimens, one from each group, for comparison after test with those subjected to the electric current.

The accompanying table shows the varying ages and mixes of the different blocks as well as the nature of the electrical current test on each block.

TABLE SHOWING DATA OF SPECIMENS.

No. of specimen.	Age in days beginning test.	Mixture by wgt., cement to sand.	Conditions of current.
1	34	1:3	CC
2	34	1:3	CC
3	51	1:3	CP
4	..	1:3	None
5	32	1:0	CC
6	32	1:0	CC
7	48	1:0	CP
8	..	1:0	None
9	29	1:1	CC
10	29	1:1	CC
11	57	1:1	CP
12	..	1:1	Reverse
13	29	3:1	CC
14	29	3:1	CC
15	54	3:1	CP
16	..	3:1	None

CONSTANT CURRENT TESTS.—Specimens 1, 2, 5, 6, 9, 10, 13, and 14 were placed in separate metal pails, containing a 3% solution of sodium chloride, and were connected in series across a suitable potential; the current was adjusted to 0.1 amp. by a variable series resistance and led into the specimen by the steel pipe as anode, whence it flowed through the concrete to the brine and out to the next specimen by the metal pail as cathode (Fig. 1). Every 24 hours the current was adjusted to 0.1 amp. and the potential difference between each anode and cathode observed by means of a volt-meter of suitable scale. The test was prolonged for 28

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†A similar set of experiments has been reported by Mr. A. A. Knudson in the Transactions of the American Institute of Electrical Engineers, v. 26, part 1, p. 231, and Engineering News, March 21, 1907, p. 328.

days, the specimens being removed from the circuit and placed to one side from time to time as their behavior warranted. The variations in potential are shown in the curves in Fig. 3.

It will be noticed that specimens 1 and 2 (containing the greatest quantity of sand, viz., 75%) failed by cracking of the concrete after seven days of test. No. 9 (50% sand) failed in a similar manner after ten days; No. 6 (neat cement), 13 and 14 (25% sand) after 15 days; No. 10 (50% sand) after 16 days; and lastly No. 5 (neat cement) after 28 days. The percentage of sand then seemed to approximately determine the life, i. e., the greater the amount of sand, the shorter the life, but this general rule was deviated from by specimens 6 and 10.

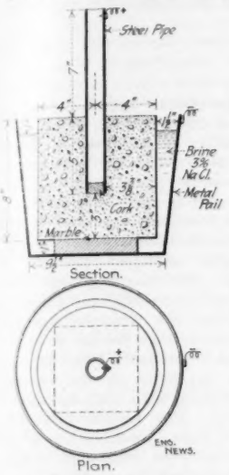

Fig. 1. Method of Testing Concrete Block Under Electric Current.

At first the cracks were fine and hair-like, and were always clearly indicated at their inception by the moisture which at once rose through the crack and dampened the surface of the top of the specimen immediately adjacent to the crack. After a few days the crack widened appreciably if the current were maintained through the specimen, and in the case of the leaner mixtures was frequently followed by a second or third radial crack of the same general appearance. After allowing the current to flow through the cracked specimens for a varying amount of time, they were disconnected and removed from the brine for closer inspection.

In specimen 1 and 2 the concrete seemed to have slightly deteriorated in places along the edges of the cracks, and appeared softer when picked with the point of a knife. These specimens were easily pried open with a screw-driver; their internal appearances were much alike. The concrete was markedly stained a reddish brown in places, by the migration of the iron towards the cathode. The anode of No. 2 showed well-marked rust stains and pitting along the surface of the steel adjacent to the line of the crack. This pitting had not extended through to the inner surface of the pipe. The anode of No. 9 had suffered similar deterioration.

Fig. 6 shows specimen No. 4 from the same group as No. 2, shown on Fig. 4. No. 4 had no current through it, and may be profitably compared with No. 2. No. 4 was found to be free from superficial exterior cracks and required about 20 blows with a heavy hammer and cold chisel before it would break open. The inner surface of concrete adjacent to the pipe was entirely free from rust stains, and the steel anode as bright and clear as the day on which it was inserted into the concrete.

The change in the potential necessary to maintain 0.1 amp. through each specimen from day to day is plotted on Fig. 3. As the current was maintained constant at 0.1 amp. a value of resistance may be obtained by dividing the voltage ordinates by 0.1. The values so obtained are "fictitious" ohmic resistances, for it was observed that a polarizing back E. M. F. of about two volts existed which prevented the determination of true ohmic resistance by the drop of potential method. However, this is not important as the results are comparative only, and not absolute. The plots on Fig. 3 show that the resistance of all the specimens increased to a maximum. At this maximum a crack always appeared, and the resistance then fell rapidly to about its original value. The range of resistance for the neat cement specimens was wide, varying from a minimum of 100 ohms to a maximum of 2,800 ohms for No. 5.

It is seen that the amount of sand is inversely proportional in general to the resistance, and the following theory is advanced as the explanation of this: The voids in the sand were determined as being nearly 50%; therefore, specimens 1, 2, 3 and 4 with only 25% of cement to fill these voids would have theoretically 25% of voids unfilled. Specimens 5, 6, 7 and 8 with 100% cement would have theoretically no voids. The greater the percentage of unfilled voids, the greater the permeability of the concrete, and hence the greater the amount of moisture present and the lower the resistance. This idea is, in the main, substantiated by resistance measurements of the untested specimens as well as by the resistance changes of the specimens under test.

In order to observe the effect upon the resistance, the circuit was opened on all specimens on the sixth day for 24 hours. All the specimens dropped, more or less, in resistance as a result of this interruption, but quickly increased again on closing the circuit.

CONSTANT POTENTIAL TEST.—The second part of the main test was the subjection of four specimens, one from each group, to a constant potential difference of about 115 volts. Lighting mains were used, and varied about 1% from time to time. Fig. 5 illustrates the effect upon one of the specimens. The action proceeded at a greatly accelerated rate owing, probably, to the increased current density.

The specimens cracked in periods ranging from five to nineteen minutes. A smell of chlorine was noticed, indicating the liberation of chlorine from the sodium chloride. This chlorine seemed to escape from the junction of the steel anode with the cement. One specimen heated up to a temperature of 55° C. (obtained by holding a thermometer against the concrete); the internal temperature was probably higher. The cracks were hair-like at their inception and indicated by moisture, as in the first test with 0.1 amps. After cracking, gases escaped vigorously from the crack. The cracks did not appear all at once but originated in one place on top of the specimen and gradually spread in a linear radial direction towards anode and cathode. The resistance changes of the four specimens are plotted on Fig. 7, and are very remarkable.

It will be remembered that under test with 0.1 amps. the resistance increased to a maximum, when the specimen cracked, and then the resistance dropped. In this case, however, exactly the opposite change took place. In every case the resistance decreased to a minimum, the specimen cracked, the crack opened, and the resistance rapidly rose to a maximum. This rise in resistance after cracking would seem to be due to the gases which rapidly filled the crack, due to the electrolytic dissociation at a rapid rate of the water which flowed in from the brine.

TEST WITH REVERSE CURRENT.—The last test was a special reverse current test on No. 12, to test some ideas. One hundred and fifteen volts was applied and the current led to the metal pail as anode, through the brine, into the concrete, and out by the steel pipe, now acting as cathode. The specimen's behavior and its change in resistance are plotted against time on Fig. 7.

The resistance fell steadily to a minimum, and then rose rapidly at the end of 65 minutes to a maximum. On opening the specimen, no rust stains at all were discoverable upon either concrete or steel, neither was the steel in any way pitted. The initial crack appeared some time before the rapid rise in resistance.

DISCUSSION OF RESULTS.

In the following discussion the test in which the current strength was maintained constant at 0.1 amps. will be referred to as the "Constant Current Test," and the test in which each specimen was subjected to 115 volts as the "Constant Potential Test."

An attempt will be made (1) to account for the presence of rust on the steel; (2) to account for the cracking of the concrete.

The following is a list of rust formers:

(a) Atmospheric air, (b) water and moisture: the latter implying quantities so minute that they are evaporated as soon as deposited on the metal (c) all organic and inorganic acids (d) all chlorine compounds of the metals, alkalis and alkaline earths, and all salts rich in or absorptive of water.

It is generally assumed that—apart from the chemical agents, acids and salts—water and oxygen are the primary causes of rust. Iron rust being a compound of iron, oxygen and water, it follows that iron can only rust when and where it is brought into contact with oxygen and water, and that if one of these two essentials is lacking, the formation of rust becomes impossible and the iron will remain unattacked. It is, therefore, safe to say that oxygen and water were present at the steel pipe in both the constant current and constant potential tests. This establishes an important fact, viz., that electrolytic and not metallic conduction occurred in the concrete, for otherwise no oxygen could have been liberated at the pipe. But the sand and cement crystals are of themselves inert non-conductors, hence the electrolytic conduction was carried on by the particles of moisture present in the voids. Well-marked rusting appeared in as short a time as 40 minutes with the constant potential test; this is possible when it is remembered that nascent oxygen (from the electrolytic dissociation of the water) and chlorine were present under pressure at the anode, and that an increase of pressure increases the oxidizing action of these elements.

The cracks in the concrete are best accounted for by the following theory of gaseous pressure: The steel pipe anode liberated two gases at its

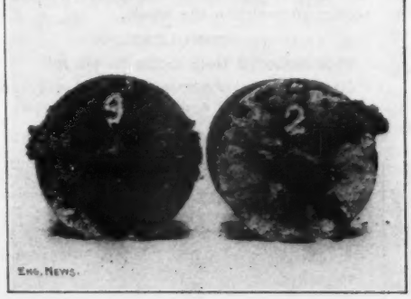

Fig. 2. Cracks in Specimens After Being Subjected to Constant Current.

Showing appearance of cracks on top side of specimens Nos. 9 and 2. The crack in No. 9 appeared as a hair line 11 days before removal, and gradually opened to the dimensions shown (about 3/16-in.). No. 2 shows three separate radial cracks, which appeared 18 days before removal.

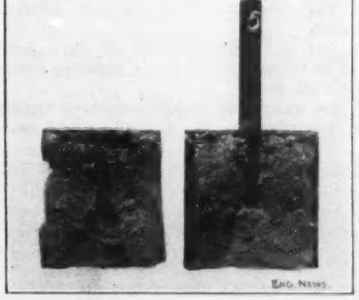

Fig. 8. View of Head Cement Specimen Under Constant Current.

Showing internal appearance of No. 5, the neat cement specimen which resisted cracking the longest, viz., for 28 days. Close examination will show a zone of discolored cement immediately adjacent to the steel anode. Instantly it cracked this specimen was removed from the circuit, and was opened with a few blows of a cold chisel. The anode was rusted.

surface, viz., oxygen and chlorine. If these gases were hindered in their escape by the surrounding concrete, they would accumulate and gradually increase in pressure. As the pressure increased the gases would penetrate into the voids. As the pressure in a particular void increased, the surrounding cement crystals would be subjected to a tensile stress—a stress which they are least able to withstand—and might reasonably crack. The minute crack thus formed would allow the gas to penetrate into the next void and there repeat the same action.

Assuming that no gas at all escaped and that the concrete and steel were separated by 0.001-in., a current of 2 amps. flowing for 20 minutes would produce a gaseous pressure around the anode of 1,200 atmospheres, at 50° C. While it is certain that no such pressure as this existed, the figures show that considerable gaseous pressures could have been created.

This theory of gaseous pressure would also account for the increase in resistance of the specimens under the constant current test. It is evident that a film of gas would form around the steel anode and thus interpose a relatively high resistance in the path of the current. Moreover, this gaseous film would be relatively more continuous in the case of the neat cement than in the case of the 75% sand specimen, owing to the greater number of voids in the latter which would offer greater facilities for the gas to escape. This, then, would account for the development of the highest resistance in the neat cement specimens, as well as the well-marked gradation of resistance which was inversely proportional to the percentage of sand present.

It is well known that rust occupies a relatively greater volume than the iron from which it is formed. Thus if a pin hole be made in a tinned iron plate and a strong rusting agent applied, rust will form under the tin and gradually pry it from the iron to which it was adhering. This phenomena gave rise to the idea that the expansion of the iron rust at the anode caused the cracking. It was proved, however, by the reverse current test that while rust expansion may have been a contributing factor to the cracking, it certainly was not the sole factor. In this test hydrogen was liberated at the steel pipe, now the cathode, and, therefore, no rusting occurred; nevertheless, the specimen cracked in 65 minutes.

The diametrically opposite behavior of resistance change in the constant current and constant potential tests is difficult to account for. Why, on increasing the current density, should the resistance decrease? A suggestion is offered by the high temperature rise of the concrete, which would have three effects:

(1) The conductivity of the salt solution is increased.

(2) The polarizing voltage of the specimen would be reduced, as it has a negative temperature coefficient.

(3) The gas at the anode, generated rapidly in large quantities by the current, would expand,

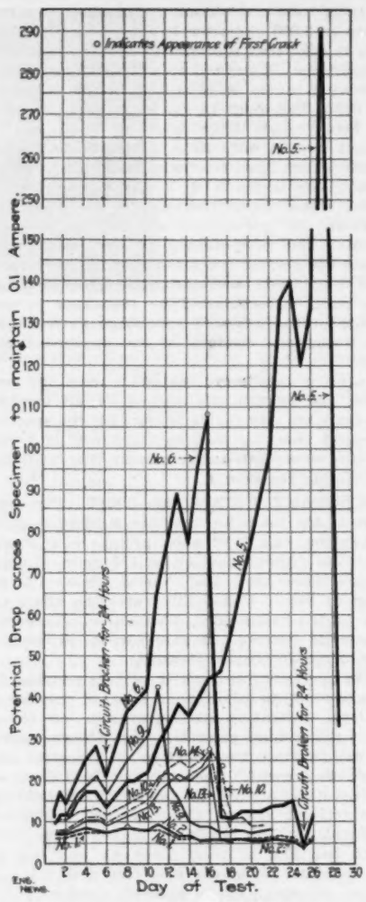

Fig. 3. Curves Showing Change in Potential on the Constant Current Tests.

and might quickly force an avenue of easy escape. This is supported by the actual observation of gas escaping from the junction of pipe and concrete in the constant potential test only.

The appearance of the cement in specimen 5 is indicative of some chemical action immediately adjacent to the anode; the cause of this was presumably the gases liberated at the anode, since the zone of discolored cement is confined to the region adjacent to the anode.

CONCLUSIONS.

This series of tests tends to prove:

(1) That electrolytic corrosion of structural and reinforcing steel embedded in concrete takes place at the anode.

(2) That even neat cement is no protection against this corrosion.

(3) That the cathode is not affected by oxidation.

(4) That cement and concrete in bulk will crack when carrying an electric current to or from embedded steel, and cannot, therefore, under these conditions be regarded as an insulator in any sense.

(5) That the concrete undergoes electrolysis and not metallic conduction.

(6) That as small a current as 0.1 amp. continuously flowing will accomplish the results indicated above.

(7) That the resistance of concrete is an inverse function of the percentage of sand.

[Mr. Nicholas' experiments apparently show that the cracking and disintegration of concrete was the same irrespective of the direction of the current, leaving out of account the accompanying effects of the corrosion of the iron electrode and of the dissemination of rust. This leads to the belief that the indirect thermal effect of the current is a more important factor than the formation of gases under sufficient pressure to rupture the concrete. We may logically infer from the pitting of the anodes that the distribution of current through the concrete was not uniform and the flow may have become so localized that its path was a relatively small part of the block. The heat developed by the passage of current would then have been correspondingly localized and confined. The temperature may be supposed to have risen considerably along the path, giving rise to local expansion, cracking and general disintegration. After such action had occurred the vapors of the released superheated moisture may logically be supposed to appear along the crack as a more or less marked ebullition. It should be remembered that in electrolytic conduction we would expect gases, when formed, to appear at the anode and cathode and not generally to spring into being along the electrolytic path. The "gases" issuing from the concrete may be only vapors and true gases may be found only at the anode and cathode surfaces with the heavier current densities.

In accounting for the presence of rust stains, through the mass of concrete, particularly in the neighborhood of cracks, there is one additional possible action that it is well to point out. It is not necessary to conceive of the electrolytic action as violent enough to have "oxygen and water present at the steel pipe," as Mr. Nicholas states. Many will believe it equally probable that the iron was dissolved as a lower (ferrous) compound and in this state carried along by the cataphoric action of the current until it became precipitated as typical red rust (ferric compound) by contact with the complicated silicates of the cement which can certainly be conceived as yielding some of their oxygen to that end.—Ed.]

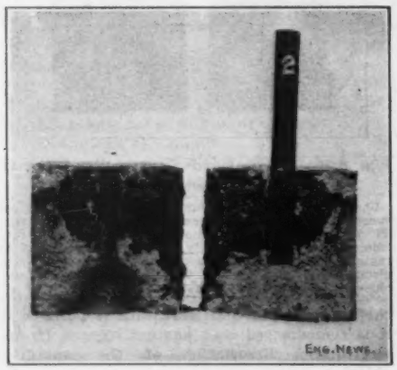

Fig. 4. Specimen No. 2 Pried Open Along the Plane of its Main Crack.

The discoloration on the concrete is a reddish brown rust stain. The anode of this specimen is illustrated on a larger scale in the next figure.

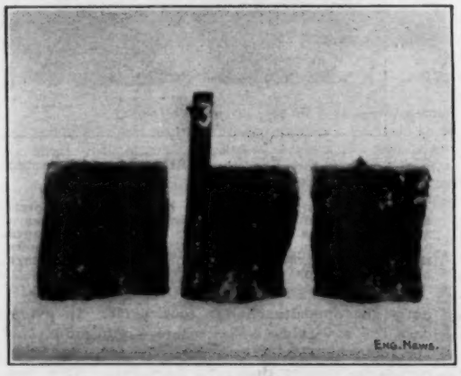

Fig. 5. Internal Appearance of No. 3.

This specimen sustained a current varying from one amp. to four amps. at 113.5 volts for 48 hours.

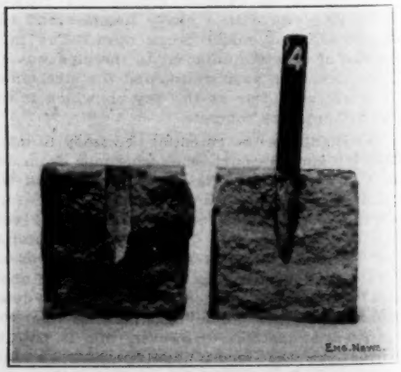

Fig. 6. Showing Internal Appearance of Specimen No. 4.

This specimen was not subjected to the passage of any current, but was kept in a brine solution as a dummy. It was forcibly broken with a heavy hammer and cold chisel, about 20 blows being necessary.

FIGS. 4 TO 6. VIEWS OF INTERIOR OF THREE SPECIMENS OF SAME MIXTURE SUBJECTED TO DIFFERENT ELECTRICAL CONDITIONS.

THE PROPOSED CHANGE TO ELECTRIC TRACTION AT THE CHICAGO TERMINAL OF THE ILLINOIS CENTRAL R. R.

One phase of the smoke abatement movement in Chicago is a demand for the consideration of the use of electric power on all the railway lines within the city. A comprehensive report on this matter has been made to the mayor recently by a special committee composed of the following members: Milton J. Foreman, Chairman of the Council Committee on Local Transportation; Dr. William A. Evans, Commissioner of Health; Paul P. Bird, Smoke Inspector; Gilbert E. Ryder, Smoke Inspection Department, and Herbert H. Evans, Mechanical Engineer.

The harm of smoke is presented by Dr. Evans, in regard both to economics and to public health. Mr. Bird discusses the prevention of smoke in Chicago, and divides the smoke producing elements into three classes: (1) stationary power plants of all kinds; (2) locomotives; (3) tugs and steamers. He shows, also, the difficulties in running locomotives without making smoke (especially at terminals), owing to conditions affecting the construction and operation of the engines. Mr. Ryder estimates that the railways burn 15% of all the coal consumed within the city limits and produce less than 10% of the total volume of smoke. But he states further that if the noise, dirt and cinders made by locomotives (both in the roundhouses and on the road) are taken into consideration, from the standpoint of a public nuisance, the locomotives stand at the head of the list. The general railway situation in Chicago is outlined as follows:

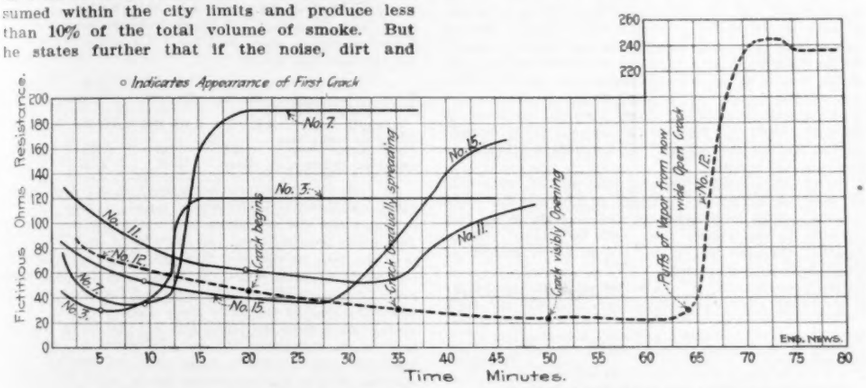

FIG. 7. FICTITIOUS OHMIC RESISTANCE ON CONSTANT POTENTIAL TEST.
(Also Specimen No. 12 Under Reverse Current Test.)

> There are at present 26 railways running trains into Chicago terminals. In addition there are belt, transfer, terminal, and industrial lines which have some or all of their trackage within the city. These run no passenger trains, but occupy themselves principally in transferring freight. The Chicago passenger terminals are six in number and are grouped around two sides of the business district. From one to six railways use each terminal. In general, the terminal is owned by one railway or by a terminal association, and the other roads use the terminal trackage to outlying portions of the city where they enter upon their own lines.
>
> All trains finish or originate their runs in Chicago; no passenger train passes through the city. The same is true of freight. At present a large portion of the through freight is brought into Chicago and transferred within the city. There is a large clearing yard southwest of the city, but it is not in general use. Bringing all this through freight into the city adds materially to the smoke nuisance. If it could be transferred through a system of clearing yards outside the city limits, a reduced expense for handling would be afforded the railways, a certain amount of congestion of terminal facilities would be avoided, generally about a day would be saved on through shipments in passing through Chicago, and the city would be cleaner. In the past there have been movements to provide a system of outside clearing yards, but progress has not been made, owing to the reluctance of certain roads to go into the scheme. We would suggest that the city offer whatever aid it consistently can in getting the railway companies to adopt a system of this kind. This would help the smoke situation and also obviate the autumnal freight congestion in Chicago.

The discussion of the use of electric traction is concentrated upon the Illinois Central Ry., not on account of any special feeling against that road, but because of the local condition which make smoke particularly objectionable in the district through which the road passes. This railway is thus one of the most serious features in the problem, and it was believed that if electrification could be shown to be feasible in the case of this one road, it might be assumed as feasible for the others. The Illinois Central Ry. is one of the two lines having the heaviest suburban traffic. It is peculiarly situated in that it traverses a thickly-settled and high-class residential district and a park and boulevard system. The smoke and cinders (and especially the latter) constitute a very decided nuisance to the residents and the general public, both indoors and outdoors. They also cause injury to trees and plants in the parks and boulevards. The noise of the engines is another objectionable feature.

Owing to the frequent station stops and the consequent frequency of starting and accelerating the suburban trains, the locomotives used in this service have necessarily a sharp exhaust. This, together with the short tubes of the small engines, results in a heavy discharge of cinders from the smokestack even when the engine is not making smoke. While the ordinary smoke can be reduced to some extent by careful firing, the conditions of operation in suburban service are not conducive to smokeless firing, and it appears to be impracticable to reduce the discharge of cinders as long as this traffic is handled by the present class of locomotives. Experiments are to be made with coke and oil fuel in this service. In addition to the suburban trains, however, there are the switching engines and the engines of heavy main line passenger and freight trains. These discharge more or less smoke and cinders, especially when stopped at stations or switches.

There are five classes of traffic to be considered if the electrification of the entire terminal system is undertaken: (1) suburban trains; (2) main line passenger trains using the terminal system; (3) main line freight trains to and from the principal freight yards; (4) freight yard switching and transfer service; (5) main line trains of four other railways using this terminal system.

(1) Suburban Trains.—The average week-day suburban traffic comprises 260 trains, of which 144 are express trains. The longest run is to Flossmoor, 24 miles. The express trains average about six miles between stops; their average speed is 34 mi. per hr., but it is estimated that this could be increased to 45 mi. per hr. by electric traction. The local trains average about one mile between stops; their average speed is from 12 to 20 mi. per hr. but could be increased to about 14 or 25 mi. per hr. with electric traction. The suburban traffic does not use the main-line terminal station, but passes on the outside, there being a suburban station near the north end of the former for convenience of transfer.

(2) Main Line Passenger Trains.—There are 78 trains daily in and out of the passenger terminal station at 12th St., and 42 of these are trains of other railways, as noted below. Most of these trains make stops at three or four suburban stations in order to accommodate the residence district.

(3) Main Line Freight Trains.—There are about 37 trains daily in and out of the freight yards at 16th St. and north of 12th St. These include nine trains of two of the foreign railways using this terminal.

(4) Yard Switching and Transfer Service.—Within the city limits the Illinois Central Ry. has three main yards at which inbound trains are broken up and outbound trains made up ready for the road engines. In this work and in the classification of the cars there is, of course, constant movement of the switching engines. In this class of service, with continual starting and stopping, efficient combustion and smoke prevention (without special fuel or apparatus) is out of the question. In addition to this, the engines have to distribute and collect cars between the main yards and the local yards and spurs of numerous industries along the line. They also have to transfer cars between the yards of the Illinois Central Ry. and those of the numerous other railways entering Chicago.

(5) Foreign Main-Line Trains.—The terminal lines and passenger station of the Illinois Central Ry. are used by four other lines. Three of these use their own engines, but it would be necessary for these to arrange to have their trains hauled by the electric locomotives of the Illinois Central Ry. terminal system. This would involve the provision of facilities at (or beyond) the city limits for changing from steam to electric locomotives. The railways in question are as follows:

(A) Chicago, Cincinnati & Louisville Ry. (4 passenger trains daily). This road uses the Illinois Central Ry. tracks to Riverdale, 17.22 miles (just outside the city limits). (B) Cleveland, Cincinnati, Chicago & St. Louis Ry. (8 passenger trains daily). This road uses the Illinois Central Ry. as far as Kankakee, 56 miles, and for this distance its trains are handled by the locomotives of the latter line. (C) Michigan Central Ry. (20 passenger trains and four freight trains daily). This road uses the Illinois Central Ry. as far as Kensington, 14½ miles, its own line extending thence four miles before reaching the city limits. (D) Wisconsin Central Ry. (10 passenger and five freight trains daily). This road runs over the Illinois Central Ry. as far as Harlem (14 miles); this is well beyond the city limits.

To deal with the suburban traffic alone would be practicable and comparatively easy, as there are numerous precedents for the handling of traffic of this kind by electricity. For this service motor cars would be used, the trains being operated on the multiple-unit system. The present project, however, calls for the use of heavy electric traction exclusively for all the classes of service noted above. This would necessitate the use of powerful electric locomotives. The main-line service would not greatly complicate matters. The yard switching and transfer work, however, would be a serious complication, and is without precedent on anything but a very small scale. In all existing cases, the freight yard work is done by steam locomotives, and the electric locomotives do little more than haul the trains between division points. For freight yard work, the third-rail system would be dangerous and even overhead equipment would be complicated at yard entrances and in large classifications yards. While the problem can undoubtedly be solved, yet the fact of its being a new problem will call for very careful investigation as to the most suitable methods for efficiently and economically performing the service under unprecedented conditions.

As to the question of operating switching movements by electric locomotives, the report states as follows:

> It is just in switching that we think electric traction would show the greatest saving over steam traction. The load is very uneven; electric traction is more adjustable than steam traction. The steam locomotive is idle much of the time, and carries full steam all of such time. Here electricity saves. The steam locomotive

does not run with equal efficiency in both directions; the electric locomotive does. The steam locomotive runs farther in making a switch. The crew is larger than for an electric locomotive, and when the engine is idle the crew is idle.

With the electric locomotive, cars can be spotted more accurately and in much less time. There is no such thing as getting on center. The upkeep is less, roundhouse charges are less, cost of cleaning is less. It can work longer hours. There is no loss going for coal or water, or other dead runs. Control is better. Acceleration is both more rapid and more economical. The cost of a switching mile is in excess of that of a straightaway mile and the coefficient of inefficiency of switching service is exceedingly high. Much of the waste is in switching and the returns from these economies should be productive in proportion to the importance of the service.

We have suggested that a special type of switching locomotive be provided for the service. For through hauling of heavy trains, the electric locomotives used for the passenger trains will of course be available. The adoption of electrical hauling for such service would give them an opportunity of returning a greater mileage per day and would probably lead to an easier care of rolling-stock demands and a lessened dead mileage. Should electrification be adopted, it is probable that for several years provision will have to be made for a few smokeless locomotives to make side trips; for instance, with stock trains to the stock yards. These may be anthracite or coke burning engines. Prudence would demand that the work and wreck trains be hauled by steam locomotives. The incoming and outgoing steam locomotives for attachment to trains at the end of the electrification could be utilized as stand-by locomotives for this service.

The report in question suggests that the electrification should be carried to the end of the electric zone; that is, all trackage between South Water St. and Flossmoor (25 miles) should be equipped for electric traction. The double-track branch from 67th St. to South Chicago, and the single-track branch to Blue Island should be included. It should be extended also on the Freeport Division as far as the junction of the Wisconsin Central Ry. at Harlem. The Michigan Central Ry. line from the junction at Kensington to the city limits should be equipped for electric traction. It is suggested that this road might establish electric traction as far as Hammond, and that it might pay to adopt this system for the heavy industrial zone east of that point.

The report suggests a combination of the third-rail and overhead wire systems, the latter being in part supplementary to the former. The third-rail is proposed for all running lines, for the greater part of the freight yards at the terminal, and for the greater part of the tracks in the vicinity of the 12th St. station. Overhead equipment is proposed where the tracks are in public streets (as on North Water St. and in South Chicago); and also for team tracks, sidings, roundhouse connections and three small yards. For points where intricate track layouts make it impossible to instal the third-rail, provision is made for special overhead work.

For important points a good steel overhead construction with a bar conductor would have to be provided, but for lightly used tracks a section of trolley wire carried overhead would suffice to get trains onto a section of third rail, should they stall. Between electrical efficiency and economy of construction at most points demanding special overhead construction the choice should be the latter.

In estimating the probable cost of electrification no provision has been made for a power station, since it is assumed that power can be purchased locally from power-supply companies for ⅞-ct. per KW.-hr., or less. If this cannot be done, the railway could put in a 12,000-KW. plant which would supply current at that figure, according to the report. It is assumed that the power would be purchased and delivered to a distributing station at 26th St., whence it would be carried to substations at Randolph St., 67th St., Kensington, Harvey and a point about four miles out on the Freeport division.

A detailed estimate of the cost of electric equipment for operating the entire terminal is given in the report. This is summarized in the accompanying table, and amounts to $3,356,931. The saving in maintenance of steam locomotives, repairs and renewals of passenger cars, water supply, coal and ash handling, and firemens' labor (60 men) is estimated at $442,467. Deducting from this the maintenance of electric plant, transmission and trolley lines, electric locomotives and car equipment, etc., the net saving is estimated at $264,097. This would be 7.87% on the estimated total investment of $3,356,931. It is stated that this does not include any estimate on the probable earning power of the electrification.

In regard to the estimate of cost, the report states as follows:

The estimated cost of $3,356,931 (not including a power house) represents the lowest probable cost of a sufficient installation. It could probably be reduced by certain economies, such as the employment of wooden poles instead of steel towers for the transmission line, or in the insulation of the third rail, but such cheapening would not be wise.

On the other hand, such cost could be considerably increased. With a free hand and only the needs of the future in prospect it might even be trebled. What provision for the future would be made would be a matter for decision by the controlling officials of the railway and purely a matter of policy. We have contented ourselves with allowing for an equipment sufficient only for the present. To offset the carrying charges thereon, we have taken into consideration only the savings to be effected in electrically handling the present traffic, with no allowance for the gains from electrification.

The provision of the cheapest satisfactory equipment for a new enterprise has seemed to us to be in line with American railway policy. Contrary to European practice, the policy in America in railway building or extension has been to provide the cheapest construction, which would still be satisfactory, until the work begins to carry itself; then to provide for the future.* Wisdom would demand a close consideration of future demands in the installation of a terminal electrification; but the giving heed to future demands would also require a looking to the future for a part of the profits. As its simplest consideration, we have preferred to chose an equipment sufficient only to the demands of the present and to look for the returns only from the savings to be immediately expected.

* There will certainly be additional traffic, there will be lessened upkeep of buildings and structures, there will be savings from switching and dead movement, not included in the above; there will be greater mileage capacity, the good will of the public, and a number of gains not easily computed.

ESTIMATES OF THE COST OF ELECTRIFICATION OF THE CHICAGO TERMINAL SYSTEM OF THE ILLINOIS CENTRAL RY.

170.7 miles of third-rail system; including supports, accessories, track bonding, installation, etc.	$1,007,009
57.8 miles of single track trolley system with bracket construction (including track bonding), at $2,860	165,336
47.9 miles of double track trolley system with span construction (including track bonding), at $5,330	255,360
5,682 ft. in warehouses, at 40 cts.	2,373
Overhead work	36,650
Car equipments for 90 cars (maximum number in use at busiest hour, 73)	450,000
Electric locomotives, 35 at $30,000	1,050,000
Distributing station	120,000
Substations (12,000-KW. equipment at $40 per KW.)	480,000
Transmission line	190,203
Changes in signals, 30 miles at $1,000	30,000
Changes in station platforms	20,000
Total	$3,806,931
Credit 30 steam locomotives for use on other parts of the line, at $15,000 (no credit allowed for the old suburban locomotives)	450,000
Total cost of electrification	$3,356,931

THE ASSOCIATION OF GERMAN PORTLAND CEMENT MANUFACTURERS; SUMMARY OF PROCEEDINGS FOR 1908—NEW GERMAN CEMENT SPECIFICATION.†

By ROBERT W. LESLEY‡ and E. W. LAZELL.§

The Association of German Portland Cement Manufacturers originated in 1865, when the "German Association for the Manufacture of Bricks, Clay Goods, Lime and Cement" was founded by a small number of interested parties. Out of this general association, which is still in existence, the German cement association grew. During the meetings of the first named body the difficulty of testing of materials came about. A committee to have charge of testing matters was formed and in January, 1877, about twenty German Portland cement manufacturers met at the call of Doctor Dolbrueck, of Stettin, and formed the "Association of German Cement Manufacturers."

The proceedings of that body for the past 30 years are familiar history to all having to do with the cement industry. Its cooperation with the various branches of the German government, its affiliation with the different engineering and architectural bodies having to do with cement, form part of the records of the history of our industry in central Europe. It was that body that had, practically, the first to do with the making of cement specifications and which was also most instrumental in defining what was unadulterated Portland cement. Its work in establishing this definition, which formed a very important part of the deliberations of the association, and its pledge to the public that its members would only make cement containing not more than 3% of foreign matter for the purpose of regulating set, is well known to all of you. From year to year the deliberations of the German association have been marked by the greatest seriousness and devotion to the best interests of Portland cement. Its leaders—such men as Dolbrueck, Shuman and Dyckerhoff—have been large contributors to the literature of our industry. In the investigation of the effect of the addition of slag to cement; in the investigation of puzzolan mortars; in the examination of the behavior of cement in salt water, the German association has been to the forefront.

The report dealing with the laboratory of the association, which is one of the principal laboratories in Europe for the handling of cement and kindred materials, was one of the features of the 1908 meeting. The report shows that during the year 1907 samples were procured in the open market representing the product of each factory in the German cement association. These were tested in the laboratory and embraced altogether 91 cements. They were tested for (1) the physical tests according to the standard method and required by the standard specifications, and (2) a chemical analysis of each cement. The following figures show data for 1:3 mortars at 28 days for the past four years:

	1904	1905	1906	1907
Tensile strength	305 lbs.	307 lbs.	363 lbs.	338 lbs.
Compression strength	3,514 lbs.	3,460 lbs.	3,567 lbs.	3,283 lbs.
Fineness on the 900 mesh sieve	1.36	1.95	1.76	1.62
Loss on ignition	2.60	2.66	2.58	2.87

All cements were volume constant in air and water. The number of cements which failed to pass the accelerated test for soundness was about the same as in 1906. The physical tests may be said to show generally that the loss on ignition developed a slight gain over the previous years, while the fineness on the 900 mesh sieve has practically not changed, and the same may be said as to that on the 5,000 mesh sieve.

From these facts the indications are that there has not been much difference in the production of Portland cements. It will also be noted that the physical tests and tensile and compression strengths show very little change during the past four years.

The effect, of course, of the laboratory procuring in the open market samples of the product manufactured by each factory and submitting them to physical tests according to the standard method and specification, is to keep up the standard of German Portland cement. These reports are made public at the meetings of the association, though the individual brands are not mentioned. This method has a considerable moral effect upon the upholding of German standards.

The chemical tests for the years 1904 to 1907, inclusive, so far as the principal ingredients are concerned, are as follows:

	1907 Maximum.	1907 Minimum.	Average value 1907	1906	1905	1904
Insoluble in hydrochloric acid	8.15	0.37	1.75	1.22	.....	.....
Silica	24.04	17.23	20.56	21.27	22.39	22.47
Alumina	9.08	2.96	7.37	7.25	7.83	7.74
Iron oxide	4.62	1.23	3.24	3.07	2.51	2.65
Lime	67.60	57.72	62.74	63.31	63.60	63.06
Magnesia	3.57	0.51	1.63	1.56	1.68	1.64
Sulphuric anhydride	3.30	0.88	1.82	1.71	1.76	1.76

Attention is here called to the variations in the above chemical tests.

STANDARD SAND.—In connection with the work of testing, the laboratory is also charged with the furnishing of the standard sand, which is supplied in sealed packages of varying sizes to all those having to do with the testing of cement. As illustrating the importance of this branch of the laboratory's work, since May, 1907, 36 tests were made of the standard sand from Freienwalde, which serve for purposes of control, and during the same period the laboratory sold no less than 1,610 sacks of the same sand between that date and the end of the year 1907.

The German standard sand is obtained from a tertiary quartz bed of the brown coal formation in the vicinity of Freienwalde. The nearly white sand is washed in a washing machine and artificially dried. The dry sand is sieved by means of a suspended sieve. The coarse sand is first removed by one sieve and the fine by another. The output of each day is controlled by tests for the size of grains and purity in the Royal Testing Material Station, Gross-Lichterfelde.

For determining the size of grains, sieves of sheet brass are used .25 mm. (.0098-in.) thick, having circular openings 1.350 and .775 mm. diameter (.053-in. and .030-in.)

After the controlling tests the sand that is standard

*This applies only to lines of light immediate traffic. Where a railway is built to handle an existing heavy traffic it is wise economy to build a line sufficiently substantial to carry this traffic (and a probable future increase) with a minimum expenditure for maintenance, renewals and reconstruction.—Editor Engineering News.

†Portion of paper read before the Association of American Portland Cement Manufacturers, Dec. 9, 1908.

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§Philadelphia, Pa.

is packed in sacks and each sack is closed with a seal of the Royal Testing Material Station.

SCIENTIFIC INVESTIGATIONS.

1. The laboratory participated in the work of the committee for the revision of the Standard Specifications.

2. The comparative strength tests, begun in 1906 with cement from all the members, were carried on:

(a) By hardening under water.
(b) By hardening in air.
(c) By hardening by exposure to the weather.
(d) By combined hardening (7 days in water, remainder in air).

In all cases the tests included 28-day, 90-day and 360-day tests.

3. The laboratory also participated in the work of Committee No. 42, of the International Society for Testing Materials, in reference to "Uniform Testing of Hydraulic Materials by Means of Prisms, and the Preparation of Normal Sand."

4. A series of investigations were made covering the transverse, tensile and compression strength of prismatic bars according to the method of Feret and Schule.

5. The tests begun in 1906 for the control of the setting time of the members' cement at regular intervals of time were carried on (after 3, 6, 9 and 12 months' storage).

6. Comparative tests for the preparation of neat cement test pieces were carried on by means of:

(a) Placing in the mold by hand.
(b) Placing in mold by the hammer apparatus.

7. Tests were undertaken concerning the durability of cement by storage, with ten fresh cements:

(a) In the condition as received.
(b) By the addition of sufficient gypsum to give a sulphuric anhydride content of 2½%.

The cement being stored as follows:

(a) In air-tight tin boxes.
(b) In sacks.

These were tested after 28, 90, 180 and 360 days storage.

(8) Two cements from Bologne were tested as given under No. 7.

9. At the request of the committee various foreign cements have been investigated.

10. Comparative tests were arranged to determine the loss on ignition of:

(a) Portland cement.
(b) Iron Portland cement.
(c) Natural cement.

11. Tests were arranged with Portland cement, iron Portland cement and natural cement to learn in what manner the time and method of heating affected the specific gravity.

Investigations were carried out by the laboratory with 87 different cements to determine the effect of storage upon setting time. The setting time was determined as received after storing 3, 6, 9 and 12 months. The results show that no definite conclusions can be drawn. Cements which gave a quick or medium setting time as received, were generally slowed by storage, while several of the slow-setting cements were quickened.

The series of investigations were also undertaken to determine the loss on ignition and the specific gravity of Portland cement, iron Portland cement and natural cement.

The loss on ignition of Portland cement differs materially from other cement. Portland cement gave the full loss in about 3 minutes heating by the Bunsen burner. Natural cement required about 20 minutes heating, and while the slag cements show in the first 3 minutes a loss, but on longer heating a gain in weight. The behavior, therefore, of cements by heating serves to distinguish the character of the cement.

NEW STANDARD SPECIFICATIONS.—The report of the laboratory on Standard Specifications for Testing Portland Cement was presented. These are the modified specifications referred to above, and in connection with which the tests mentioned were conducted. The new definitions are extremely interesting and are very well stated. They differ from the American Standard Specifications in the sense that they embrace under a single head Methods of Manipulation and Standard Specifications; and, further, that in each section there is given (1) the specification itself and (2) right below it, full explanations under the title of "Essential Principles and Explanations." In this way the reader, or the tester, has before him on a single page the actual requirement of the specification and the reasons for its adoption, and the methods for its use.

The definition of Portland cement is given as follows:

Portland cement is a hydraulic cementing material with not less than 1.7 parts by weight of lime to 1 part by weight of soluble silica alumina iron oxide, prepared by fine grinding and intimate mixing of the raw materials, then burning at least to sintering and again fine grinding. To this cement shall not be added more than 3% of other material for particular purposes.

The maximum magnesia content shall not exceed 4% and the sulphuric anhydride shall not exceed 2½%.

It will be noted in this connection that the sulphuric anhydride has been raised from 2 to 2½%.

Under the head of Packing and Weight, the following is the specification, and as the "Essential Principles and Explanations," together with the obligation of the association, are of considerable interest they are also given below:

Portland cement is packed in sacks and barrels. The packages must carry besides the gross weight, the term "Portland Cement" and the name of the manufacturer, clearly printed thereon.

Loss by sifting out and variations from the standard weight to the amount of 2% are allowable.

ESSENTIAL PRINCIPLES AND EXPLANATIONS.

As various weights are in use in sacks as well as barrels, it is absolutely necessary to give the gross weight.

By the term Portland cement, the purchaser shall be assured that the material is in accordance with the definition given above.*

SETTING.

The initial set of normal Portland cement shall not take place in less than one hour after gaging. For particular purposes a quicker setting Portland cement can be prepared, such cement, however, shall be so marked on the package.

ESSENTIAL PRINCIPLES AND EXPLANATIONS.

The initial set of normal Portland cement should require at least one hour, because the beginning of the setting is important; on the contrary, if a definite interval of time is required for the hard set it is of less value in the use of Portland cement, if the process of hardening is completed in a shorter or longer time. Possibly specifications concerning the setting time should, therefore, not be limited too closely.

CONSTANCY OF VOLUME.

Portland cement must be volume constant. It shall be recognized as decisive proof of this that when a part of neat cement, prepared on a glass plate and protected from drying out, placed under water after 24 hours, shows no sign of curvature or cracking on the edge after a long time.

FINENESS OF GRINDING.

Portland cement shall be ground so fine that it leaves a residue of not more than 5% on a sieve of 900 meshes per sq. cm., the width of the mesh of the sieve being .22 mm. (corresponding approximately to a sieve having 76 meshes per linear inch, width of the mesh being .0087-in.).

STRENGTH TESTS.

The binding strength of Portland cement shall be determined by testing a mixture of cement and sand. Tests shall be made for the compression and tensile strength according to uniform methods, by means of test pieces prepared the same way and of the same area and with the same apparatus.

The compression tests are to be made on cubes of 50 sq. cm. (7.75 sq ins.) surface and the tensile tests on test pieces having a least section of 5 sq. cm. (.775-sq. in.)

COMPRESSION AND TENSILE STRENGTH.

Slow-setting Portland cement shall show at least 160 kg. per sq. cm. (2,275 lbs. per sq. in.) compressive strength when tested with 3 parts by weight of standard sand and 1 part by weight of Portland cement after 28 days hardening (1 day in air, 27 days in water). The tensile strength shall be at least 16 kg. per sq. cm. (227 lbs. per sq. in.)

The strength of quick setting Portland cement is generally less at 28 days than that given before. On this account the strength specified should be regulated by the setting time.

The compression strength must be at least 200 kg. per sq. cm. (2,844 lbs. per sq. in.) by testing after one day in moist air, 6 days in water and 21 days in air of a temperature of from 15 to 30° C. (59 to 86° F.), the tensile strength shall be at least 20 kg. per sq. cm. (284 lbs. per sq. in.).

Compression tests may be made at an earlier time after one day in moist air and 6 days in water when the compressive strength shall be at least 120 kg. per sq. cm. (1,760 lbs. per sq. in.).

REPORT OF THE STATUS OF MIXED CEMENTS.

Following the presentation and discusion of the specifications a most important discussion took place on the "Status of Slag Admixtures." The principal speaker was Dr. Rudolph Dyckerhoff, who went very fully into the subject of the addition of ground slag to Portland cement, a material which in Germany is sold under the title of "Iron Portland Cement," which title the German Cement Association strenuously objects to. In connection with this, Dr. Dyckerhoff submitted a number of comparative tables of iron Portland cements, and Portland cements manufactured in the regular way, and concluded by arguing strongly against the designation of iron Portland cement for materials of the character described, namely, mixtures of pulverized slag and Portland cement.

*The Association of German Portland Cement Manufacturers obligates and controls its members to maintain the standard conditions given above and the therein required properties for Portland cement.

This obligation reads:

"The members of this association are permitted to bring into the market under the term 'Portland Cement' only such material as is prepared from an intimate mixture of lime and clay materials as essential ingredients, burning to sintering and subsequent grinding to the finest of flour. They obligate themselves not to recognize as Portland cement any material which is prepared otherwise than above stated, or which during or after the burning has been mixed with foreign bodies, and to look upon the sale of other material under the name of Portland cement as deceiving the purchaser. These requirements are not to forbid the addition of not more than 3% of other material to the Portland cement for the purpose of regulating the setting time.

"The members of the association further obligate themselves to furnish Portland cement which will in all respects meet the requirements of the Prussian Minister of Public Works.

"When a consumer requires cement for a particular purpose, coarser ground than the requirements, or colored, its preparation is allowable.

"If a member of the association offends the above given obligation he shall be expelled from the association. His expulsion is made known publicly.

"The manufactured product of each member of the association is tested yearly in the laboratory of the association at Karlshorst, near Berlin; and the results are given out at the general meeting of the association."

A NEW PRECISE MEASUREMENT METHOD WITH SPECIAL LINE CLINOMETERS AND TAPE STRETCHERS.

By EDWARD H. HOLDEN.*

The relation of traverse work to triangulation is a most important one and one often misunderstood. The idea that traverse work connecting triangulation can be of an indifferent quality, because the triangulation is precise, is an erroneous one. It is absolutely essential that the traverse work shall be systematically uniform, if the determinations of the traverse stations are to have a true and consistent relation to the triangulation. So that the only safe procedure in this class of work is to employ the most accurate method whereby the error will be minimized and will approach equal magnitude and equal sign.

In the Borough of the Bronx, New York City, the primary traverses, those connecting the triangulation stations, are made as accurately as possible, and nothing has been spared to secure this accuracy. Certain mechanical devices have suggested themselves to take the place of stakes, the driving of stakes being an expensive and a disadvantageous method and, at times,

Fig. 1. View of the Line-Clinometer.
(Built by Keuffel & Esser from designs of Edward H. Holden.)

prohibitive. Portable tripods have generally been substituted for stakes, necessitating simultaneous leveling and a field force of from eight to ten men. By separating this force into two parties, namely, the transit party for the observation of angles and the chaining party for the measurement of lines, decided advantages are derived. The transit party consists of three men and the chaining party consists of five men, with a chief of party over all.

This separation of work suggested the application of a telescope to the portable tripod whereby the alinement and gradient of the tape lengths could be given, and the transit, level and rod eliminated from the chaining party. Following this suggestion a method of measurement has been devised which makes use of several novel instruments and which has proved very successful.

TAPES.

The steel tapes used have a cross-section of ¼-in. by 1/50-in., generally 150 ft. long, and have only three graduated marks, at the front, rear and middle points, respectively. The tape is supported at each end, and in case of the 150-ft. tape at the middle. Thermometers are attached to the tape at each end, the metal back of the thermometer being in contact with the tape. The tape extends about 3 ft. beyond the end graduations and terminates in loops which are put over the hooks of the tape stretchers.

*Asst. Engineer in Charge of Surveys and Monumenting, Borough of The Bronx, New York City.

The tension applied is 15 kilograms (about 33 lbs.). The determination of tape lengths is made by direct contact, no plumb bobs being used.

Invar tapes, made of an alloy of nickel and steel are also used. They have a coefficient of expansion extremely small, being one-thirtieth that of steel. They have a cross-section of ¼ of an in. by 1/50-in., and are used in the same manner as steel tapes. (For invar tapes see U. S. Coast & Geodetic Survey Report for 1907, Appendix No. 4, Eng. News, Dec. 5, 1907, p. 612.)

LINE-CLINOMETER.

This instrument (Fig. 1), invented by the writer and manufactured by Keuffel & Esser, is a portable tripod with a plunging level giving alinement and grade. It consists of a level (wye form) which rotates vertically around horizontal arms forming part of the level bar, an arc and vernier measuring the vertical angle. The connecting piece between the level bar and the leveling head is U-shaped, with the "U" resting on one side, thereby permitting the tape to come directly in alinement at an index post set in the lower part of the "U." The index post carries at its side an eccentric cylinder (not visible in half-tone) which forms the support for the tape, the eccentricity allowing varying thickness of tape to have the upper surface at the same level with the index mark. The U-shaped piece rests on a sliding head which, by a slow motion screw, moves forward and backward in the direction of the line. Below this is the ordinary leveling head with a shifting center. The tripod is an extension one with telescopic legs. Where greatest precision is desired, a transit placed off at one side, on a right-angle, sets the tripod vertically over the point in the ground. A plumb-bob is suspended from the instrument as in a transit, for use in setting up in line, and can be used in setting the instrument over the station, and also determining the cut-off. A scale reading by vernier to 0.0001 ft. measures the sliding motion. When the scale is set at zero, the index mark is at the center of the instrument, directly over the plumb-bob. The scale reads backwards and forwards from zero.

The advantages of the instrument are:

1. Separation of the lineal from the angular measurements, resulting in economy of time. The old method has the disadvantage that when the angles were being measured the chaining party was idle, and vice versa.
2. Reduction of the field force from eight to five men.
3. Ease of adjustments of the level versus those of the transit for vertical angles and collimation.
4. Check on the gradients, the vertical angle being observed by each instrument.
5. The observers, being responsible for the work, are most qualified to do the instrumental work and do so at no expense of time.
6. Elimination of the errors of plumb-bobs.
7. Avoidance of time and expense of driving stakes.
8. Availability where stakes are prohibited, e. g., parks, pavements, etc., etc.

TAPE STRETCHERS.

The front stretcher (Fig. 3) consists of an upright (a twin bar of iron) hinging sideways at its lower end on a foot base and terminating at the top in a handle. On this upright, traveling up and down, is a block which supports the spring balance. The tension is applied by a half-wheel, centered in the block and working by a lever attached to its diameter. A strap connects the wheel motion to a rod which carries the spring balance. By means of the vertical motion of the block, the balance and front end of the tape is raised or lowered, while the hinge motion of the upright gives lateral motion for alinement. The rear stretcher is similar to the front stretcher, in that it has no spring balance. A clamp on the foot-base regulates the friction necessary for the upright to be self-supporting.

The advantages of the stretchers are:

1. Ease of manipulation.
2. Absolute control, the tension being maintained constant for a longer time than with other forms.
3. With the tension released it is self-supporting, allowing the operator to quickly ward off an approaching interference, thus protecting the tape from injury. These stretchers can be used in standardizing tapes and hold to a ten-thousandth of a foot.

FIG. 2. ACCURATE LINE MEASUREMENT USING THE SPECIAL LINE-CLINOMETERS AND TAPE STRETCHERS DEVISED BY E. H. HOLDEN.

FIELD PROCEDURE.

The measuring or chaining party consists of two observers, two tape stretchers and one recorder, who attends to the middle support.

Suppose the line A-B is to be measured. One of the line-clinometers, which we will call No. 1, is set over the point A; the telescope is sighted to B and clamped horizontally; the rear stretcher is placed back of A and the rear graduation of the tape is brought to coincide with the index mark of instrument. The front stretcher is placed ahead with proper tension

Fig. 3. Tape Stretcher.

applied and the front graduation of tape is brought in line by instrument No. 1. Instrument No. 2 is brought up to the front graduation; the tripod is made firm and, by the shifting center, the index mark is brought approximately in contact with the front graduation of tape; in the meantime, the center support (which is a staff 1 in. square with a sliding target and having a wire nail projecting for the tape support) is being placed by instrument No. 1 in line and on grade of the two telescopes. Observer No. 2 brings, by the slow motion screw, the mark of the index post in contact with front graduation of the tape. When the approaches this, he calls "ready," and when the rear calls "right," he makes the contact and calls "right." Observer No. 1 has been watching his contact and instantly responds if the tape is steady; if not, he calls "steady," and the signals are repeated. Upon simultaneous signals of "right," each observer reads the thermometer and then the vertical angle. The tape is then carried forward, the rear holding at instrument No. 2, instrument No. 1 going forward. The telescope of No. 2 is taken out of the wyes and reversed, end for end, and sighted toward B. If not found on it, the slight movement to bring it on will not affect the position of the index mark. Instrument No. 2 gives the alinement for the second tape length and the operation is repeated for the whole line. Fig. 2 shows the party at work. In this view the tape has been shortened so that the whole operation could be shown clearly in one photograph.

Errors of line measurement are those due to (1) temperature, (2) tension, (3) grade and (4) those due to contact or mechanical errors. By confining these to certain limits, the accuracy of the work becomes known. With the use of invar tapes, the errors of temperature have been reduced from being the largest factor to one of the smallest.

The following table of error factors will illustrate:

INVAR TAPES.

Classification of errors.	Maximum average error per 150-ft. tape length.	Error per mile.
Temperature	2° F.	.0026 ft.
Tension	1 oz.	.0042 ft.
Slope	20 ins.	.0175 ft.
Mechanical	0.0002 ft.	.0070 ft.
Total		.0313 ft.

STEEL TAPES.

Temperature	2° F.	.0082 ft.
Tension	1 oz.	.0042 ft.
Slope	20 ins.	.0175 ft.
Mechanical	0.0002 ft.	.0070 ft.
Total		.0369 ft.

These tables give a fair idea of the comparative values of the errors as applied to the foregoing field practice. The error of standardizing the tape lengths has not been introduced, as that is independent of the field errors and gives no values to the different field methods. The limits of error given are liberal. With invar tapes and this measuring outfit, there is no reason why measurements should not be made with an error less than ⅝-in. per mile. Many precise measurements with steel tapes have been made in the Borough of the Bronx with errors less than 0.06 ft. per mile; many are far below that.

With invar tapes it is expected to come within an error of 0.01 ft. per mile.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.
220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

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Entered at the New York Post-Office as Second-Class Matter.

If any of our readers have been misled by recent sensational newspaper headlines concerning the Gatun dam at Panama, we commend to their attention the two articles in this issue by a well-known engineer, Mr. C. M. Saville, M. Am. Soc. C. E., relative to this dam.

Space unfortunately prevents the publication of Mr. Saville's complete report. We believe the portion we publish, however, will be sufficient to convince any engineer who knows anything about the principles of earth dam construction that the structure at Gatun is as sound and safe as any engineering work could possibly be. Indeed, the criticism of the design made to us personally by one well-known engineer expert in earth dam construction is that the dam is so absolutely safe that at least half its width is wholly useless. It is undoubtedly the case that the long toe of the dam on the seaward side is a concession to the fears and the ignorance of some of the engineers originally connected with the work who were better posted on bridge and railway work than on dam construction.

We believe we speak advisedly in saying that not one of the published criticisms of the Gatun dam which have appeared in the newspapers of late have brought forward a single technical fact or argument worth the attention of the engineering profession. It is not difficult, either, to find the inspiration for most of these widely published statements. One of the most pretentious of these prophets of evil, for example, is a French engineer who had his own pet plan for building the canal. He wanted to transform the Culebra cut into a lake and excavate it by dredging under water with Lobnitz chisels instead of in the dry. He submitted his fantastic plan to the International Board of Consulting Engineers, which was, of course, compelled to turn it down; and of course the French engineer has lost no opportunity to criticize Panama methods since. There are other critics of Panama who have likewise had pet plans for carrying out the work which have not been adopted, and who have spared no pains since in criticizing the work which is being done there.

We believe that if right standards of professional ethics prevailed, such practices would meet with general condemnation among engineers. In a paper at the Mechanical Engineer's meeting this month on the relations of the engineer to the public, the idea was put forward that it is the duty of the engineering profession to see that the public is properly informed on public questions in which engineering is involved.

It may be too much to hope for this advanced position at present; but it is surely the duty of engineers to refrain from circulating misinformation and misleading the public on engineering questions.

Of course it is not uncommon for inventors, whose schemes are turned down by a concern, to seek revenge by public criticisms; but any man aspiring to the title of engineer ought to be above such practises. Particularly is this the case where an engineer acquires reputation, so that his name carries weight with the public. Such an engineer ought to be particularly careful in his public utterances not to mislead the public in any way.

And if an individual engineer should be careful of his public utterances, much more should an engineering society. It is idle to say that the common disclaimer of responsibility for statements made in papers and discussions before the society really absolves it from responsibility. Actually the society is just as responsible for its publications and for the good or harm they may do as is the editor of a journal.

A remarkable illustration of what may result from carelessness as to obligations of this sort is a paper widely circulated last week by the American Institute of Mining Engineers. The paper advocates a change to a sea-level canal at Panama and advocates it on the ground that the author of the paper has invented some excavating machinery which he believes would so revolutionize the work at Panama that a sea-level canal could be dug inside of two years!

It is a standing rule with reputable engineering journals of good standing not to print descriptions of new inventions until they are actually built or tested. In this paper, however, published under the auspices of a national engineering society, *seven* different new machines and methods of excavation are described, not one of which has ever been built or even reduced to working drawings! It is a long road from the first crude ideas of the inventor to actual practical use in engineering work. Would a mining company, after spending millions in the development of a huge ore deposit by shafts and tunnels under advice of the best engineers, suddenly abandon the whole and adopt stripping merely because an inventor brought them some sketches of a new type of steam shovel? It would be vastly absurd for the United States to change the type of canal at Panama because of some undeveloped inventions in excavating machinery.

If the American Institute of Mining Engineers values its reputation as a serious professional society, it ought to promptly withdraw the paper referred to and undo, so far as possible, the harm it has done in misleading the public.

It is not at all difficult, as we have shown above, to account for the alarmist reports concerning the Panama plans and work. Besides the interviews given out by the disgruntled ones, whose ideas did not prevail, we have the undoubted fact that the newspapers give large space to every scare story from Panama and practically ignore statements of responsible engineers giving the real truth. The settling of the waste rock dumped in the mud in the old French canal channel along the south toe of the dam has been magnified into a disaster of ominous portent to the whole work. Stories concerning it have been published in ten thousand newspapers, while hardly one has published the real truth—that the settlement of the rock was expected to occur and saved the needless expense of dredging out the layer of soft mud before dumping the rock.

Of course the Administration has to recognize the effect of such stories upon the popular mind; and it has been decided to send down to Panama, with President-elect Taft, a party of well-known engineers who will inspect the entire work and advise the Government whether the present plans and methods being pursued are sound and safe in every particular.

The application of electric traction to the suburban service and the entire terminal system of the Illinois Central Ry. at Chicago, is now being pressed upon the railway company by the city. This is due largely to the special inconveniences and annoyances caused by smoke and cinders in the residence district through which the line passes. The matter is now under investigation both by the city and the railway. The general conditions of the problem and the solution as suggested by the city are presented in another column. The question of electric traction for the Chicago suburban service of the Illinois Central Ry. was investigated very thoroughly in 1891 by Mr. John F. Wallace, M. Am. Soc. C. E., then Chief Engineer of that railway. He described this investigation and its results in a paper presented to the American Society of Civil Engineers (Transactions, Am. Soc., C. E., June, 1897; Vol. XXXVII.). It was concluded that while it might be practicable to operate this service by electricity it would not be economical. The matter was considered again by the railway company in 1896, but with the same result. Since then it has been brought up at various times by outside parties, usually in connection with the smoke nuisance, but always without practical result. During 1908, the matter was agitated actively by local organizations and by the city authorities, with such force that the railway company has undertaken to investigate the question of introducing electric traction for its entire terminal system.

At the time of Mr. Wallace's investigation, electric traction had been applied mainly to street railway service, and its application to general railway work was in its infancy. In fact, the investigation was based largely upon the comparison of a frequent service of small train units operated by electricity and the ordinary service of larger train units operated by steam locomotives. Since then, there has been a remarkable development in the use of electric traction for heavy suburban traffic and for handling enormously heavy trains. This puts the matter in a very different position from that in which it stood in 1891 or 1896. The present proposition for the Illinois Central Ry. includes the operation of the regular suburban train units by electric power (employing motor cars), and also the operation of all main line trains and switching service by means of electric locomotives. The handling of switching service in large freight yards by electricity has not been involved in the electrification works hitherto carried out by steam railways.

A revolutionary change is now going on in the methods of transportation between the different boroughs of New York City. Until the completion of the Brooklyn Bridge in 1884, all traffic across the East River, between New York and Brooklyn was carried on by the ferries. While the opening of the Brooklyn Bridge made some inroads upon the ferry traffic, its competition was partially offset by the rapid increase in travel between the two cities and by the crowded conditions of travel on the bridge.

The recent completion of the Williamsburg Bridge and the opening of the Rapid Transit subway tunnel at the Battery, however, have altered conditions, and the East River ferries, which were once extremely profitable, have been rapidly running down until they no longer pay expenses. The companies which operate them, therefore, have been making arrangements to go out of business, and on Dec. 14 five of the ferry lines finally abandoned operation. This caused great inconvenience to the merchants and manufacturers doing business near the water fronts in both New York and Brooklyn. In order to send trucks from these districts across

the river by one of the bridges, a long journey must be made back to the bridge approach on either side and then a continuous up grade must be climbed to a height of 135 ft. above the water.

Of course, the ferry companies cannot be compelled by any process of law to continue to carry on an unprofitable business. It has been proposed that the city take over and operate the ferries, but it is difficult to see why the taxpayers should be assessed to carry on an unprofitable transportation business. Undoubtedly the rates charged on the ferries ought to be made large enough to pay the cost of operation, but the difficulty here encountered is that the increase in rates drives away some of the traffic and necessitates a still further increase in rates to meet expenses. Probably the best solution will be to reduce very considerably the number of ferry lines. By concentrating the traffic at a few points, and running boats at less frequent intervals, enough business can probably be obtained to make the ferries pay their expenses. An incidental advantage of such a change will be the releasing of much valuable water front now occupied by the ferries and much needed for other purposes.

On the North River likewise, the opening of the Hudson Companies tunnels is likely to make radical changes in ferry transportation conditions. The tunnels now in operation have greatly reduced the travel on the Lackawanna Railroad's 23d St. ferry. However, all the wagon traffic over the North River must still be carried by the ferries as the tunnels only provide for passenger traffic.

A paper on the floods of the Mississippi Delta appears in the November issue of the "Proceedings" of the American Society of Civil Engineers, written by Col. William D. Pickett, who is, by the way, the oldest living member of the society. Col. Pickett's paper refers especially to the influence of the runoff from the headwaters of the Missouri River, upon floods in the lower Mississippi. He urges that with a larger use for irrigation of the streams in the Far West, together with forestation of the elevated plateaus in the Rockies, considerable diminution would result in the floods flowing down the Missouri.

Col. Pickett is doubtless right as to the effect of such measures upon the floods in the Missouri; but, as was pointed out in the valuable series of papers contributed by the late Maj. William Starling to the columns of Engineering News a dozen years ago, extremely high floods in the Lower Mississippi are frequently produced by the outflow from the tributaries coming from the east, regardless of conditions in the Missouri.

One point of special interest in Col. Pickett's paper relates to the influence of forests upon stream flow. Col. Chittenden, in his much-discussed paper in our issue of Oct. 29 last, said, referring to the influence of forests upon snowfall:

> While, therefore, it is constantly asserted that our mountain forests are necessary for the supply of water for irrigation, the exact reverse is the case, and the supply would be more copious and more uniform if the forests were not there.

As those of our readers who carefully studied Col. Chittenden's paper will recall, this statement was based on the theory that the forests prevented the accumulation of the snow in drifts, and hence that the snow took a longer time to melt where it fell in the open.

In contrast with this very surprising statement by Col. Chittenden, the following quotation from Col. Pickett's paper is of special interest. Prefacing it, we may remark that Col. Pickett lived for 20 years on the Upper Grey Bull River in Wyoming, at an elevation of nearly 7,000 ft., and was thus able to personally observe the conditions of snowfall and snow melting:

> By April 1, the snows in the timber on the high mountain plateaus have usually settled to a depth of from 4 to 5 ft. On account of the low temperatures peculiar to an altitude of 8,000 or 9,000 ft., the snow does not usually commence melting in the open tracts until about May 1. It melts so rapidly, however, that by June 10 the grass is in such an advanced stage that cattle from the ranches below are taken, at about that date, to these upper mountain plateaus to be kept there until the November snows.
>
> In the forests contiguous to these open spaces, the snow does not usually disappear until the beginning of August.
>
> This, in a nutshell, tells the value of forests in conserving the snows of winter. In other words, forests of average density and at the average altitude of their habitat, 8,000 to 9,000 ft., will preserve the snows of winter from melting two months longer than open areas exposed to the direct rays of the run.

Col. Pickett presents many other facts from personal observation, in his paper, in support of the statement above quoted; but that statement contains the meat of the proposition, and will be seen to be an exact contradiction of Col. Chittenden's theory.

A little thought as to the conditions which obtain at high altitudes will make clear the reasons why Col. Pickett's statement is what would naturally be expected to occur. At the high altitudes which are under discussion, the prevailing temperatures are low until the season is far advanced, and the snow which is protected by the shade of evergreen forests is, therefore, preserved until late in the summer—as was indeed admitted by Col. Chittenden. But the melting of snow by the sun's heat in the forest produces always a steady flow in the streams, and never a flood. The action takes place only during the middle of the day; the temperature drops nearly or quite to the freezing point after sundown, or even before, to remain there until late the next morning.

It would seem perhaps unnecessary to refer to this matter again, but the importance of the forests to the irrigation interests of the Far West is so great that no statement by a high scientific authority to the effect that they are injurious instead of beneficial should be allowed to go uncontroverted.

The paper on the Kern River hydro-electric power plant, printed in this issue, is one of the most valuable professional contributions that has appeared in our volume now nearing completion. We call special attention to it because it furnishes an excellent illustration of how a descriptive article on an engineering work ought to be written. As we have several times pointed out in these columns, there is much printed matter masquerading as technical literature, which is of very little practical usefulness to anything or anybody. It is one thing to describe a piece of engineering work and tell merely what was done and it is quite another to write of the same work and tell what special problems were encountered by the engineers and what methods were adopted for their solution. One sort of article—the write-up sort, as it is commonly called—is merely advertising masquerading under the appearance of technical literature. The other sort of article has as its main object contribution to the common fund of recorded professional knowledge.

In the design of hydraulic power plants in this country, the engineers in charge have very frequently left to the manufacturers all responsibility in connection with the design of the turbines, and not a few of the plants thus built have encountered serious difficulties in operation.

The fact has come to be realized now that in a hydro-electric plant the whole apparatus—penstock, turbines and generators—is actually one machine and ought to be designed as a unit with due consideration of the influence of one part upon another in order to secure the best results.

So far as we recall, such work as Mr. Finkle describes in the design of turbine buckets has nowhere before been put on record.

CONCRETE AS A CONDUCTOR OF ELECTRICITY.

In view of the general but vague apprehension that has been felt by many engineers as to the integrity of buried concrete-steel work since the publication of the experiments of Mr. A. A. Knudson,* it seems of interest to call attention to the corroborative experiments of Mr. U. J. Nicholas, described in another part of this issue. It must be remarked, however, that the experiments noted neither greatly extend our knowledge nor allow a much more definite explanation of the phenomena than we were able to make in our comments on the work of Mr. Knudson.* No more can be done than to compare the little that is known with the many things on which we need light, in the hope that some investigators may be led to study some of the questions given. Here seems a good field for college laboratory and field experimentation.

One fact stands out prominent and seems well established. Concrete is not an insulator of electricity (speaking of insulators from the practical side rather than from the pure physics which recognizes no complete insulator) and it conducts electrolytically rather than as a metal.

From studies made on concrete, in connection with apparatus for the protection of electrical circuits against lightning, it seems to have been settled that the conductivity, as affected by age or temperature, depends on that amount of the originally placed water remaining at the time of experiment. It is believed that the part of this moisture affecting conductivity, exists in a solution of the cement silicates which acts as an electrolyte diffused through the solid then serving as a mechanical carrier or holder. It seems to have been established that in a series of mortars there is a progressive resistance with increasing amounts of sand used. This leads to the view that the sand acts as an insulator diffused through the mortar. These studies in connection with lightning-protection apparatus were on unsubmerged concrete, and Mr. Nicholas' article shows how those characteristics are changed by submersion and a consequent increase of the moisture carried, in one form or another.

It has not been shown, so far as we know, whether the disintegration of unsubmerged concrete and the corrosion of imbedded iron is similar to that under water as in the tests of Mr. Knudson and Mr. Nicholas. That would be interesting data if it were forthcoming. We would like to emphasize here the statements made in our issue of March 21, 1907, of the great desirability of investigating certain questions in connection with this disintegration. These are: (1) the influence of varying the character of the concrete; (2) the effects of surface treatment to produce impervious concrete; (3) the influence of surface coatings of tar or bitumens; (4) the nature of the observed disintegration; (5) the action of independent concrete and reinforced-concrete barriers across the path of ground currents. To these it seems desirable to add; (6) the effect on the electrical properties of concrete, of adding alumn or other electrolytes for the purpose of increasing strength or impermeability.

In the work reported to date, two independent effects of the passage of electric current have been shown. In the first place the concrete softens, and perhaps otherwise disintegrates, by the passage of appreciable currents into or out of its mass. In the second place if the current passes from imbedded iron or steel into concrete the metal is dissolved and rust is disseminated through the concrete.

The first of these effects has not been shown to be a purely electrical phenomena. It may be an indirect thermal action of the current. It may be a chemical attack of released vapors and gases. Apparently the data obtained, when viewed in the light of our limited knowledge of the chemistry and physics of hydraulic elements, allows no positive explanations or assured statements. The call needs to be made stronger and to be spread wider for more study and experiment in this most important field.

We find, on studying these experiments of Mr. Nicholas that with 0.1 amp. flowing there was approximately 20 sq. ins. of steel in contact with moist concrete. This is an average current density of about 0.7 amp. per sq. ft. Such a current density surely is unsafe but in any modern structure, with great masses of iron imbedded in greater masses of concrete, the presence of any such large currents should be recognized by other effects about the structure. The danger lies in not needing any such average density as 0.7 amp. per sq. ft. to work damage. With all the chances in favor of concentrating the current

*Transactions of the American Institute of Electrical Engineers, Vol. 26, Part I, p. 231.

*Engineering News, March 21, 1907.

flow it seems unwise to state that any figure of average current density is permissible. Where any evidence is found of the passage of currents in buried concrete-steel structures every attempt should be made to remove possible electrical contacts of the imbedded steel work and where practical to undertake the insulation of the concrete masses from ground water.

The case of modern steel-framed buildings comes to mind. How great is the actual danger of impairing the foundations? Assume that the steel frame rests on and is in metallic contact with a steel grillage imbedded in a huge concrete slab. The building towers upward for 25 or 50 stories, say, with its steel frame hidden between a stone exterior and a plaster interior. The possibilities of electrical contact to the frame are commonly confined to the gas, water and electric service mains. The gas and water systems may be collectors of small currents from a territory of positive potential or they may be distributors of smaller or greater currents through an area of negative potential. These areas of positive and negative potential between the earth and pipe systems are known to exist as a result of the spread of ground-return electric-railway systems. The imaginary steel-framed building may be placed in one or the other of these areas and then a chance contact of the pipe system may throw small currents into the frame and through the concrete foundations. The probabilities are small but the possibilities are great. The absolute prevention of trouble, though obvious, is difficult—insulate all piping from the frame.

The chance of currents from electric service mains is still more remote and is practically confined to an accident which might throw a considerable current into the frame and foundation. We may safely assume that a large enough current or of sufficient duration to cause trouble in the foundations would create some disturbance at the power-supply station which would be traced out quickly.

How the foundations will be affected, by virtue of being partial barriers in the paths of currents that may be flowing in the ground, cannot certainly be stated in the absence of actual data. Comparing the very large volume of earth, that may serve as a path for ground currents, with the relatively small isolated mass of the concrete, it seems improbable that the foundations would carry appreciable currents. The indirect thermal effects of such current would probably not be manifest. Any chemical action would probably be unimportant and slow in manifesting itself. The actual danger is negligible, so far as present knowledge allows us to judge of it.

There is still one more remote source of danger, the possibilities of which may be mentioned. In some of the largest cities where an elevated steel structure carries electric trains, a few buildings have passenger bridges direct to this structure. The elevated steel work generally acts as a return circuit for the train current which is liable to seek a short cut from the structure to the power-house, via the earth. Should the bridges between the buildings and the elevated structure have been allowed to furnish contact between the two steel works, then the foundation of the building may be said to be in danger. We have not examined any of these bridges with this in mind, but the possibility of chance contact needs to be remembered.

Taken all in all, the danger to isolated buildings does not seem to be alarming. Some studies of the electrical conditions of foundations of steel buildings would, however, be profitable and might furnish interesting reading.

LETTERS TO THE EDITOR.

Contemporaneous Tests to Determine Time of Concrete Form Removal.

Sir: We note in your issue of Dec. 3, p. 617, an editorial on the relation of temperature to the removal of concrete forms. It has always appeared to us that a simple and practical test of the materials of which a structure is built, subjected to the same conditions as the structure, was far better than any data which might be secured from tests made with other materials and under different conditions. That is to say, experiments as to the time required for concrete to set at different temperatures would by no means afford as safe a basis for stripping forms as an actual crushing test of cubes made from the same materials and at the same time as the structure, and allowed to set under the same conditions. We suggested this method in our 1908 handbook on p. 177 under the heading of "Hints for Specification Writers," and we there made a number of suggestions along this line, which we believe may be of interest to some of your readers. We feel very strongly that a proper system of tests would prevent such accidents as your article refers to.

Very truly yours,
Ransome Concrete Machinery Co.

Dunellen, N. J., Dec. 5, 1908.

[Where conditions are favorable for the testing of such blocks as are mentioned by our correspondent there is no doubt that such testing is eminently desirable, but it must be remembered that testing machines capable of crushing a 12-in. cube are not often available near construction work, and the cost and trouble of sending the test pieces to the nearest machine would be prohibitive in most cases. Tension tests are more conveniently made, but the relation between the mortar briquette in tension and stone concrete in compression is not as direct as might be desired. Temporary compression testing devices might be rigged up on the job, if the work were extensive enough to warrant it, but such devices are troublesome and costly to operate and hardly very accurate. The general tests which we suggested as desirable would cover the work where contemporaneous testing is impossible.—Ed.]

The Corps of Engineers and the President's Message.

Sir: After reading the first editorial in your issue of Dec. 3 on the Gatun Dam scares, one wonders how such misinformation as you have noted originates, and in what way the instigator expects to derive credit or benefit. However, it is very easy for some small insignificant statement, starting as far away as Panama, to assume considerable size by time it reaches New York.

But after reading in the daily press of Dec. 9, the following head lines: "New Methods for the Water-Ways."—"Roosevelt Says Plans That Have So Signally Failed Should Be Abandoned for New Ones."—"Action Wanted At Once."—"Engineers Can't Take 'Broad View'—Permanent Commission Should Have Charge of River Matters"; one ceases to wonder, for here is one case right at home wherein the editors in all probability misconstrued the real meaning of the President. Even if we grant that the editor himself has been able to read between the lines, and has placed the blame up above the Engineer Corps (which in reality is where most of it belongs), there is very little doubt but that the general reader will take the matter as a whole at its face value, and assume that if we will only kick out the "narrow-minded Engineers"—who, by the way, have given the best years of their life to the study of these problems, and put in their stead others, having no greater experience nor ability (for they could not be found), we will soon see ocean-going vessels plying all of the so-called navigable streams in the United States.

There is no doubt but that the President means to handle the subject in a broad way, as was evidenced some time ago when he appointed the Inland Waterways Commission; but after a careful reading of that part of his recent message which deals with this feature of the case, the writer must admit that parts of the same are unfair, and will surely bring about an unjust and undeserved impeachment of the many works of the Engineer Corps, a very large proportion of which have been highly beneficial, and in which the country received full value for the money expended.

With a general knowledge of all sides of the question, it is hard to understand why a body of engineers, created by Congress, subjected to the rules and regulations of Congress, and executing the work as directed and located by Congress, should be censured when they are only responsible for an honest and economical execution of the works assigned to them, in so far as they control.

The admirable record of this body of Government Officers as regards integrity and honest performance of duty needs no defense. It is probably true that Government work, as a rule, costs a little more than that done under private management; but this is almost invariably due to restrictions placed by Congress upon the manner of handling the work, the Officer being hemmed about with rules and regulations that will not permit of the most economical execution in this progressive day.

These remarks refer to the silt-bearing streams having a large variation in gage height, which is about the only class of work, of the many handled by the Engineer Corps, with which the writer is familiar. There is no other class of work wherein there is such a large element of uncertainty as regards the results that may be expected under given conditions, because of the many variable factors to be constantly dealt with.

When this work was started, about 30 years ago, there was very little if any precedent, and it was quite natural that mistakes would be made, and that the plans would have to be changed as knowledge was gained. It is a matter of record, however, that in a very large number of instances the failure of the work placed was directly due to the failure of Congress to appropriate funds for the maintenance of the works which it had deemed of sufficient importance to authorize; and this in spite of the repeated reports from the Officers in charge that without the repairs the works could not be maintained.

In citing the improvement of the Ohio as an instance "of the utter waste caused by the methods which have hitherto obtained for the so-called improvement of navigation," by calling attention to the fact that it was found necessary to change plans first submitted in 1824, the impression is conveyed that works constructed under them were not in every way suited to the shipping then plying, or would later be expected to ply, on the Ohio River. In fact, the change was not in the plan, but mainly in the sizes of the different works to be built under that plan, in order to accommodate the larger boats now plying that stream. The responsibility for the delay in the execution of the work, so far as apparent, lies entirely with Congress in failing to furnish the necessary funds. It is a safe prediction that the dam and lock plan will have to be carried out on this river before it will be navigable at all seasons of the year, even if the lands around the head waters are reforested.

It is true that the Corps of Engineers is hemmed about with traditions, many of which it would be best to abandon, and it is also true that they make mistakes like anybody else, the latest one being that of the Chief of Engineers in proposing a plan for increasing the number of Engineer Officers by selections from West Point graduates now in the army at large who have had very little if any engineering training; instead of selecting from the large body of well trained and thoroughly competent Civilian Engineers now in the employ of the Engineer Corps; men who have spent their entire professional careers in this service, and are really in most cases the power behind the throne that supplies the information contained in the several reports submitted by the officers in charge. This is no reflection upon these officers, but a natural consequence of the plan pursued in changing the stations of these Officers about once every three years. You stated very truly in the editorial in your issue of Nov. 26, 1908, "that Gen. Marshall has missed a great opportunity." There is hardly a doubt but that there will be a very large increase, within a few years, in the amount of river improvement work to be handled, and that the necessary additions to the Engineer Corps will be made from the only men trained in this work, viz., the U. S. Assistant Engineers.

Does not this "Broad View," which the writer believes should be called the "Popular Magazine View," owe its origin, in a great measure, to the educational campaign instituted several years ago, by the Rivers and Harbors Congress, and carried on under the very able and efficient leadership of Congressman Joseph E. Ransdell, president of the Congress, who, together with his associates, is accomplishing a very important and necessary work preliminary to the general improvement of our inland waterways.

Is it not time now to change the ruling or admonition made some three years ago by the President-elect, then Secretary of War, which effected the exclusion from the Rivers and Harbors Congress of the members of the Engineer Corps and their Assistants engaged in river and harbor work, and make it obligatory that at least one or more should attend from each district. These men are needed as a safety-valve, now that the matter has gotten to the stage where it is necessary to know what amount of money can be economically and profitably expended; they are needed to impress upon all concerned that the question of making the silt-bearing streams of the Mississippi valley permanently navigable is a stupendous undertaking and will require many years and enormous sums of money to accomplish, besides a large amount annually for maintenance and repairs. There is now much danger of over-confidence, and danger of implanting the belief that a few years of large appropriations will give us the desired navigability, then failure of accomplishment will bring about reaction which will soon be reflected in Congress, funds will not be supplied, and we will have, as we have to-day, a number of incompleted works and no money to maintain them; and the engineers will be accused of incapacity.

The Secretary of War very truly stated, as quoted by the President, that: "The chief defect in the methods hitherto pursued lies in the absence of executive authority for originating comprehensive plans covering the country or natural divisions thereof." But can we charge all of this against the Engineer Corps? Have they not submitted plan after plan without getting the funds to carry them out? Is it not the undisputed evidence of the able Chairman of the Rivers and Harbors Committee (and there is no one

who has a more comprehensive understanding of the entire situation) that worthy objects presented represent sums of money several times as great as he and his associates can find means to authorize?

Let Congress give a legal standing to the Inland Waterways Commission already appointed by the President, and provide the necessary funds for its successful operation, even if it cannot pass a River and Harbor bill at this session. This, in the opinion of the writer, will be a great step forward; and we can soon have a comprehensive plan to follow. Then we must have sufficient funds, to complete the entire plan, available at such a rate as will permit of the most economical execution of the plan. And let the progress of the work not depend upon annual appropriations. We have not yet gotten away from the danger that the political whims of the leaders in control may have greater weight than the actual needs of the work, in determining as to whether or not appropriations should be continued. It has not been so many years ago but that we can all remember, when the River and Harbor bill was the subject of much deserved criticism; and the chief local excuse for an appropriation was that it was the means of placing money in circulation.

Again referring to the Ohio River, and considering the facts, it is very hard to understand and harmonize all of the mistakes that are charged up against the Engineer Corps. The most incomprehensible one being: that their methods, which are termed short-sighted, vacillating and futile, are accompanied by increasing floods; and by decreasing water-born commerce; when it is a fact that the great bulk of the commerce in this river comes out on the flood stages.

There are doubtless many engineers not prominent in the Engineer Corps, who are inclined to believe that there is not sufficient accurate data available to show that the forests have any appreciable effect upon the flood stages of the rivers; but who are willing and glad to get any information based upon facts and not upon theory and belief, which bears upon this subject. On this account, the Engineer Officers who have recently appeared in print deserve the hearty thanks of their brother engineers for presenting any facts they may have, whether they run counter to popular belief or not.

Chas. H. Miller.

423 Southern Trust Building, Little Rock, Ark., Dec. 12, 1908.

Some Useful Hints to Engineers Applying for Positions.

Sir: Some letters were recently published in Engineering News about engineers in charge of work not replying to letters written them by applicants for positions, even when the latter enclosed stamps.

Some time since the writer was named in the engineering papers as "Chief Engineer" of a projected line. He was, as a matter of fact, only the locating engineer. He received about fifty letters of application, and a study of these gave him some light as to why such letters are often not answered. I tried to answer every one, but it made inroads on my spare time, and crippled my reading.

I may say that the line, if constructed, would have had need of three resident engineers in charge of 20 miles of line each, six instrument men at $75 each, working under the above, and the usual rodmen, axemen, etc. The following are some of the letters received:

A. Starts his letter with the statement that he will not leave his present position unless he can secure "At least $250 per month and expenses," and then gives his education and experience as "Two years of the C. E. course at the ——— University, 3 mos. as chainman, 7 mos. as rodman, 8 mos. as transitman, 4 mos. as Chief Engineer, 1 mo. as resident engineer and 3 mos. as 'Engineer in charge of construction, salary $175 per mo. and expenses.'" He was in New Mexico when he wrote.

B. Asks a position as resident engineer at a salary not less than $150 and expenses, and gives his education and experience as "Graduated from ——— University, six mos. as transitman in Indiana, 5 mos. on a railroad in North Carolina, and 6 mos. on a railroad in California," from which state he wrote.

C. Gives no detail of his education. Reports five months as rodman on construction, four months as instrumentman on location and seven months as resident engineer on construction. It was known to me that the road he was on used this title for the position ordinarily called instrumentman. He will not accept less than $150 per month.

D. This man is in Florida, and the fare to the place where the work is located would be about $30. He asks a place as rodman which pays about $50 per month.

I answered all of these letters by working at them Sunday afternoon after a forenoon spent on the map and profile. Perhaps I made enemies of all. I told "A" that we could not use him. I told "B" that it would not pay him to come to Arkansas for as short a job as ours promised to be. I also added that he would create a better impression if he were to omit his North Carolina experience, as the record as he gave it raised a presumption that the man was possibly running away from a record. I wrote "C" a conscientious letter, explained to him the disadvantage he would be under in dealing with the shrewd engineer and foreman of the contractor, and advised him to accept a position as instrumentman for a year or two under an experienced engineer. "D" I advised to apply for work closer to his location, and named several possible places.

If applicants would put themselves in the place of the employer, and try to look at their letter as he must, considerable postage might be saved. Where an employer does not know the applicant, a statement of the work he has done should be of such detail as to enable the reader to see what it was. If you have been on short jobs, state why. Often a record looks bad, being a succession of short jobs, six months or so, when a fuller explanation might show the applicant to have been with the same superior through several pieces of work. A man on a short job, made so by its nature, as a piece of location or construction which was completed in from four to six months, and who is soon employed again by the same engineer on another job makes a record which may be superior to that of a man staying long in one place. His employer had a chance to get rid of him without a discharge, but sought and re-employed him.

Again, heavy rock work may not be a test of a man's ability on construction. The problems of location are vastly different in a mountainous and rolling region. The writer had been on location about Lake Superior with a 2% grade and 10° curve limit for two seasons. He was sent to eastern Nebraska where he was to use an 0.8 grade and 2° curve maximum. It was noon before he thought it necessary to plat up his profile in the easy country. When done it showed him in a 30-ft. cut out on comparatively level prairie. He had to go back to his starting point and work over again. But construction shows less difference. There is more at stake in cross-sectioning a rock cut than a dirt bank. Nevertheless the dirt bank may bring slides which give the engineer much worry.

Again, the term of service is not all. If the name of the employer is given, it may tell much. I know men whose discharge of a subordinate is a higher endorsement than any letter they could give. But care should be taken not to speak ill of a former employer.

It is not necessary to explain your failures. We have all made them and have each of us been discharged. Don't mention your failures at all. Don't misrepresent, but don't tell of your weaknesses. If you do, the prospective employer is apt to think them greater than you represent.

Finally, it is best to apply for work reasonably close to where you are, unless you have special reasons for wishing to get into the country where the proposed work is.

Assistant Engineer.

Nov. 7, 1908.

[Our correspondent's suggestions can be read with profit by those who write letters applying for positions and also by those who write advertisements offering their services. The man who writes an advertisement—or anything else for that matter—ought to put himself in the place of the reader of the ad. and try and see just what he will want to know.

And this applies as much to the writers of "Situations Open" advertisements as "Situations Wanted." In the first place, it is *very much to be preferred* when a concern advertises for a man that they advertise under their own name. We appreciate that there are often objections to this; but on the other hand a concern so advertising, if it is reputable and responsible, and the place it wishes to fill is an attractive one, will have more answers, and from a higher class of men, than will be received if the advertisement is inserted anonymously.

It is sometimes objected that an advertisement under a correct name will bring a multitude of personal applications, but where this is objectionable, this can be met by requiring applicants to reply by letter only.

Some of our readers have gone so far as to request that we refuse to insert "Situations Open" cards unless the real name of the advertiser is stated; but so long as human nature and prejudice continue as at present, such a move, we conceive, would be against the interests of our readers. We do urge, however, where those desiring engineers advertise anonymously, that they make their wants as definite as possible. Not only the kind of engineering work should be made clear but the location, the probable duration of the work and the probable salary offered, should all be specified as nearly as may be. It is common (and proper) to ask applicants to state their age; but if the advertiser wants a man under 30, or over 40 for example, a statement of that fact would tend to limit the number of those who write needlessly in answer to the advertisement.

If a company advertising for engineers will make it very clear just what they desire and what they do not desire, they will not only save many men from wasting time in writing answers but will save their own time in replying to applicants of this class.—Ed.]

Forests, Snowfall and Stream Flow in the Mountains of Wyoming.

Sir: The paper of Colonel Chittenden, appearing in the "Proceedings Am. Soc. C. E." for September of this year has brought forth some interesting reviews and discussions which I have followed in the publications of the Society and in the leading engineering journals. I am confident that all who are familiar with conditions in the mountain regions of the West, where our forests are largely found, will agree with Colonel Chittenden in his conclusions. It is possible that there are localities in the East where forests may have such an influence on stream flow as has been attributed to them by popular rather than scientific authorities.

Several of those who have taken part in this discussion refer to the days of their childhood, when forests were found on every hand, when streams furnished a steady flow and when floods were not common. They do not give us any data by which we may arrive at a knowledge as to when their childhood observations were made, how much cultivation has occurred since the forests disappeared, and what kind of vegetable growth has taken the place of the forests. Neither have we any information from them relative to the rainfall during the years covered by their observations, the character of the drainage area, kind of soil, slope, etc. Without this information it is difficult to understand how those who read are to ascertain whether or not conclusions are based on fact or fancy.

The officers of the U. S. Weather Bureau have for many years studied precipitation problems. I have been unable to find, in any of the reports of that department, anything that would lead one to believe that forests have any appreciable effect on rainfall. Until this important branch of the Government Service shows us that there is some relation between forests and precipitation, the man with scientific attainments will not be in haste to conclude that forests are a great factor in influencing rain and snow fall.

It has been my lot to spend many months in the mountains of the West. The great problem here is not to prevent floods, because these are always of but local importance and of no great consequence, but to obtain the largest volume of water possible during the season when it is most needed for the irrigation of crops. The streams of the East are utilized for navigation and power, as well as to furnish water for domestic purposes. The problems that confront the people of the humid districts of the country are therefore different from those with which we have to deal, because our needs and purposes are different.

It is not my intention to enter into a discussion of this subject in detail. My convictions have been established by observation and measurement covering a period of over twenty years. If any engineer has any doubt as to the truth of Colonel Chittenden's conclusions, in so far as the timbered area of our mountains are concerned, I shall take great pleasure in conducting him into any of our numerous ranges next spring before the snows begin to melt. This is what he will find: The timbered areas will be covered with a blanket of snow. The bleak mountain tops above timber line will appear to be covered with the same blanket. As we ascend the mountains, however, it will be found that the snow on the high rocky slopes lies in depths varying from a few inches to thirty feet and over. By carrying a thermometer it will be found that it is warmer on the treeless slopes than it is in the forests while the sun is shining directly upon them. It will be found that when the sun is obscured it is warmer under and among the trees. When the weather begins to grow warmer it will be noticed that the snow lying thinly on the exposed, treeless areas first disappears. The great drifts surrounding these areas of light snow fall above timber line, show but little tendency to change. The snows in the forests being distributed in a uniform depth, gradually settle, absorbing such water as may melt and the surface freezing each night. As the season grows later, the great drifts above the forests begin to settle gradually and the streams are largely supplied from areas where the snowfall has been from one to three feet in depth, and where melting is not delayed by the shade of the trees. As the season advances, and some time between the first of May and the middle of June, depending on the lateness of the spring, the snow in the forested areas begins to melt and as this lies to a practically uniform depth, the entire timbered area furnishes water to a stream and its tributaries at the same time, and owing to the saturated condition of the snow it disappears within a few days. What floods we have,

regularly each year, come from the forested areas. These do more damage to irrigation works by carrying timber which lodges in dams and headgates than is done by the effect of high water alone.

When we consider the character of the timber grown on the mountains of the intermountain region and estimate the volume of water that is necessary for the production of this timber, it then becomes an economic question whether or not our farmers can ultimately afford to permit the growth of trees to the injury of the total available water supply. Before many years all the waters of our streams will be stored and held until the irrigation season begins. When this condition arises our agricultural growth will be hampered unless all of the water that can be obtained for this higher use can be made available. Since every irrigator plants trees, this transition will tend to increase rather than to diminish the forest area and the available timber supply.

By the first of July the snow has disappeared from the forested areas and the water supply thereafter is derived from occasional rains and the great snow banks in the mountains above timber line. It is possible to find here and there a small quantity of snow in the forests of our mountains after July 1. For twenty years the writer has been searching for snow in the forests during August, the month when water is most needed for irrigation. Thus far he has failed.

It is fortunate that this important subject is receiving some intelligent study and that we are finally obtaining discussions which deal with facts rather than with boyhood dreams and theories which are unsupported by experiment or scientific observation. The forestry work of the government should not be affected in any way by the solution of the problems which now confront us in this investigation. If the forest service rightly has a place under the national Government, this place is assured, because its value to the public must depend upon the protection it affords to forests and to the timber supply. It is not necessary for this one department to attempt to perform everything and particularly to make claims which would lead one to believe that trees do not belong to the vegetable kingdom, in that they conserve more water than they need in their growth and development.

Sincerely yours,
Clarence T. Johnston,
State Engineer.

Cheyenne, Wyoming, Nov. 30, 1908.

[Our correspondent's letter was received after the editorial note on page 718, giving the quotation from Col. Pickett's paper was in type. Col. Pickett, it will be noted, declares that the forest shade delays the melting of the snow.

It is of great interest to compare the statements in the above letter with those of Col. Pickett. Both Col. Pickett and Mr. Johnston refer to observations in the highlands of Wyoming and the two draw diametrically opposite conclusions from these observations. The statements of the two observers are not far apart; but Col. Pickett apparently refers to a more northern locality where lower temperatures prevailed. It is noteworthy that Mr Johnston admits that the snow lies longer in the forest than in adjacent open spaces. Whether he thinks the accumulation in great drifts would delay the melting still more, if the forest were entirely removed, is not quite clear.

Mr. Johnston's main objection to the forest seems to be that it will absorb some part of the total annual rainfall and decrease the total run-off. There is a *possibility* that this objection may be well grounded; but surely we ought to have nothing short of absolute certainty in place of mere possibility before sanctioning any movement to remove the forests from about the sources of the rivers in the arid West. If these forests were to be removed and it were then found that a mistake had been made, the damage done might be irreparable.

While the weight of evidence indicates that, *in most localities*, the existence of a forest does not increase the total rainfall, there are places where it seems well established that a heavy rainfall is largely influenced by the forest. One such case is quoted by Mr. J. Francis L. Baron, M. Am. Soc. C. E., in the discussion on Col. Chittenden's paper. We quote from "Proc. Am. Soc. C. E.," for November, 1908, p. 1305, as follows:

The writer must take exception to what he considers too sweeping a generalization of the statement that "there is really very little, theoretically, to support the claim that forests insure precipitation." It is undoubtedly true that when warm, moisture-laden air strikes a cold air current, the moisture will be precipitated in the form of rain. Forests are sometimes warm and sometimes cold. In northern latitudes forests are warm in winter and cool in summer; in the tropics, they are always cooler than the open, where the sun's rays are unimpeded. Take, for instance, the thick forests that clothe the eastern slopes of Nicaragua. For many months in the year, the warm trade-winds that have passed over the Caribbean Sea blow day after day from the coast over these forests, and the precipitation is phenomenal.

There may be, as the author says, "very little to support the claim, theoretically"; but, practically, it is abundantly proven throughout the whole of that relatively narrow isthmus known as Central America, from Guatemala to Panama, as the writer has frequently observed. This phenomenon is particularly noticeable in Nicaragua, and the influence of the forest is there particularly observable, because that country is, in general, low, so that the excessive rainfall on the eastern side, amounting to 365 ins. per year at Greytown, cannot be attributed to mountains. On the western side of that Republic, the precipitation is only about 45 ins., and the forests are very different, being more open, and there are many large areas of cultivated lands and unwooded plains. All the moisture held by the eastern trade-winds is dropped when they pass over the dense and cool forest jungles that cover the entire eastern water-shed.

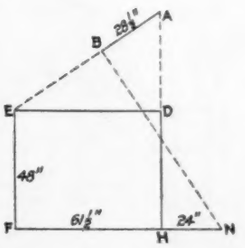
The author falls into another error of generalization, due, probably, to the fact that his observations have been confined to the limited area of the central and western United States. He states that "precipitation is nearly always greater upon the hills than upon the neighboring lowlands." This statement is quite true in British Columbia, where the observed rainfall in the Fraser River Valley is about 60 ins., while less than ten miles away, at Lake Coquitlam among the mountains, but in the same water-shed, the precipitation is 130 ins. On the Central American Isthmus, however, the reverse is true. While the precipitation at Greytown is 365 ins., and at Bluefields, about 290 ins., at Tegucigalpa, Honduras, at an elevation of 3,000 ft. above the sea, it is about 90 ins., and at Suina, Nicaragua, about 260 miles from the sea, it is about 100 ins.

Before we permit the forests to be removed from high mountain slopes of the Far West, we ought to be very sure that their presence there has no influence in increasing the precipitation from the clouds.—Ed.]

Notes and Queries.

Mr. B. E. Clark, of the Guanajuato Power & Electric Co., Colorado Springs, Colo., sends in the appended problem for the consideration of our readers. He states that his solution involves a fourth degree equation.

Communications should be sent to Mr. Clark and not to this office.



Given the rectangle *FEDH* 48 × 61½ ins. Produce *FH* 24 ins. to *N*. Produce *HD* towards *A*. What must be the length of *DA* so that, if *A* and *E* are connected, a perpendicular from *N* upon *AE* will intersect at 28½ ins. from *A* towards *E*, that is at *B*?

THE FIRST NATIONAL FOREST east of the Mississippi River has been created in Florida by a proclamation recently issued by President Roosevelt. It is located in Marion County and will be known as the Ocala National Forest. This reserve has an area of 201,480 acres, and covers a plateau between the St. Johns and Ochlawaha rivers. It has a maximum elevation of not over 150 ft. The area shows growths of pine, bald cypress, tupelo gum, water oak, ash, elm and other hard woods. It is thought that it is well adapted to a dense stand of sand pine. The soil is of little value for agricultural purposes.

The Dakota National Forest has also been created by presidential proclamation. This forest is located in Billings County, North Dakota, and has an area of 14,080 acres, located in the Bad Lands region. The creation of this forest reserve is deemed important, as it will make possible experimental forest planting in "the least forested State in the Union, having only 1% of tree growth."

RICHARD H. SOULE.

It is with great regret that we record the death of Richard H. Soule, M. Am. Soc. M. E., for many years a well-known figure among railway engineers in the field of rolling-stock work. Mr. Soule's health failed some five years ago, and he was obliged to retire from active business. His death occurred at his residence in Brookline, Mass., where he has resided for the past few years, on Sunday, Dec. 13.

Mr. Soule was born in Boston, Mass., on Dec. 4, 1849. He entered railway work in 1875, in the Mechanical Engineer's office of the Pennsylvania R. R. at Altoona. Here Mr. Soule

R. H. Soule.

formed one of a group of bright and active young men who received there a thorough practical training in the mechanical engineering problems connected with railway rolling-stock, and whose work in future years, in high official positions with the different railways of the country, has been of untold value in bringing about advancement. Mr. Soule remained with the Pennsylvania System for eight years. Beginning as a draftsman, he was quickly promoted to the test department, and four years after his first start he was made superintendent of motive power on the Northern Central Ry. In 1881 he was transferred to the same position on the Philadelphia & Erie Division, and in the following year he held the same position with the Pittsburg, Cincinnati & St. Louis Ry. In 1883, when the unfortunate West Shore Railway enterprise was carried through, its managers engaged the best talent available in the country for their managing officers, and Mr. Soule was appointed superintendent of motive power. He remained there until the absorption of the West Shore line by the New York Central in 1887, and then was appointed general manager of the Erie System, then known as the New York, Lake Erie & Western R. R. After a year in this position he was appointed general agent of the Union Switch & Signal Co., and was engaged until 1891 in the introduction of modern interlocking and lock-signaling plants. From 1891 to 1897 he was superintendent of motive power on the Norfolk & Western R. R., and did much to put the rolling-stock of the system—which was at that time coming into prominence as an important coal-carrying road—onto a thoroughly sound and progressive basis. For the two years following, Mr. Soule was engaged with the Baldwin Locomotive Works, spending nearly a year traveling in foreign countries and a year and a half in charge of the company's Chicago office.

In 1900 Mr. Soule opened an office in New York City as a consulting mechanical engineer and practised until he was attacked with a serious kidney trouble in 1904. A surgical operation was successful in prolonging his life, but his health compelled his retirement from active business.

Mr. Soule was one of the most prominent and valued members of the American Railway Master Car Builders' and Master Mechanics' Associations, and his work in connection with these associations was exceedingly valuable. It may be mentioned here that he was the author of a report on the standards of the former association, which led to a revolutionary change in the association's practice and to the placing of the standards on a much higher basis. He was also a member of the American Society of Mechanical Engineers, and served as one of the managers of the association from 1898 to 1901.

Mr. Soule was a man of most attractive personal qualities, and won the respect and esteem of his associates wherever he went. There are many engineers scattered through the country who can testify to the help given them in early life by Mr. Soule.

The funeral services were held at All Saints' Church, Brookline, Mass., on Dec. 16, and the interment was at Mt. Auburn Cemetery.

A REPORT ON THE FOUNDATIONS AND CONSTRUCTION OF THE GATUN DAM.

In view of the vast amount of discussion that has taken place concerning the design of the Gatun dam on the Panama Canal, the engineers of the work have given extraordinary care to the investigation of all problems connected with the structure. These investigations have been conducted by Mr. C. M. Saville, M. Am. Soc. C. E. Appendix E of the recently issued report of the Canal Commission contains Mr. Saville's report in full.

The two chief questions which have been investigated are the character of the foundation material underneath the dam and the stability and water-tightness of the dam itself. In connection with the latter part of these investigations, a section of a dam was constructed one-twelfth the size of the Gatun Dam at its maximum section, and experiments were made with it. The report of these experiments is reprinted elsewhere in this issue. Below we reproduce the first portion to Mr. Saville's report, in which the conclusions he reaches as a result of his investigations are summarized. We also reproduce a profile of the dam, taken along its axis and showing the results of the latest borings into the material beneath it.

It may be mentioned here that Mr. Saville's complete report occupies 70 pages of the Commission's public report, and is accompanied by 111 plates. It forms a valuable addition to the existing professional literature on the design of earth dams.

The investigations at Gatun were begun about Dec. 1, 1907, and their sequence and character are given below.

The first work undertaken was for the purpose of locating a sufficient quantity of material suitable for a dam which was to be built by the sluicing process. Material which seemed to be suitable for this work has been located down the Chagres River valley north of the proposed dam, and also to the south of the dam in the Gatuncillo River valley. Besides the above, the records of previous preliminary borings indicate a quantity of material that may be suitable in the valley of the Chagres also south of the dam. All these areas are within 1½ miles of the dam in locations suitable for hydraulic dredging. The total quantity available is apparently not less than 20,000,000 cu. yds., based on excavation not lower than 50 ft. below sea level. If it should appear that sufficient material is not available in these localities, an additional amount could be obtained from the excavation in Limon Bay.

The next work undertaken was the investigation of foundations for the dam and spillway. Much work on these lines had previously been done, and at first it was intended merely to verify and interpret that which had gone before. As the work advanced, however, some new questions arose, and by order of the chief engineer careful and systematic investigations of the valley and its rock bottom were undertaken. It was especially directed that careful search should be made to show whether there were any permeable connections through the alluvial deposits in the comparatively narrow gorges across which the dam will be built between the extensive swamp areas to the north and the broad flats of the Gatuncillo and Chagres to the south. Besides this, it was directed that the alluvial deposits in the gorges and the rocks underlying them and outcropping in the hills should be carefully studied to determine their ability to support the proposed structure and to resist the flow of water through them. The conclusions arrived at on these matters are:

(1) The rocks themselves, even those portions which are soft and readily yield to excavation methods, are of sufficient strength to support any loads that may come on them in the proposed construction.

(2) Some of the rocks are of open texture, and permit the flow of water, the readiness with which this flow is allowed depending mostly on the condition of the rock and its resistance to the disintegrating action of surface conditions.

The principal water-bearing medium seems to be the joints and seams which cut through the various strata and allow the passage of large quantities of water. The occurrence of water-bearing joint planes in great part, and to a lesser degree the presence of a layer of disintegrated conglomerate of coarse sandstone at the southerly entrance of the spillway, will undoubtedly require the construction of a masonry cut-off wall in the hill at this point. This work, however, presents no serious difficulty and only such engineering construction as is ordinarily encountered in dam building. The excavation for this wall will be in comparatively compact rock, which will excavate easily but will not require complicated bracing, if any at all is necessary. A comparatively impervious layer for the footing of the wall will be found at no excessive depth.

The alluvial deposits in the gorges of the Chagres River, across which the dam will be built, are composed almost wholly of a very fine sand with a large proportion of clay from the surface down for a considerable distance, the maximum depth at one point being about 80 ft. Underlying this for a distance of 100 ft. or more is a thick deposit of blue clay containing little sand and some shells. Beneath this, and directly overlying the rock, is a deposit varying in thickness up to 20 ft., and containing small bowlders and angular gravels and sands thoroughly consolidated and cemented together with finely divided clays and silts. This breccia resembles somewhat the "hard pan," a "glacial till" of the northern countries. It is apparently the product of the decomposition of the immediate rock surface. Of itself it is waterproof and nonwaterbearing, having been made so by the leaching and filling from the overlying deposits. When exposed to any powerful washing action, however, the material breaks down, the clay is dissolved and washed out, and the resulting sample has all the characteristics of a coarse gravel or sand that might be freely water bearing. That this is not the case is shown by numerous borings and samples. The artesian flows encountered in this material are probably local in their occurrence and due to the action of water which takes its pressure from the near-by hills. This water, however, is shut in by the impervious conditions of the material as a whole, and thus pent up it indicates a greater head than would be the case if it had free discharge.

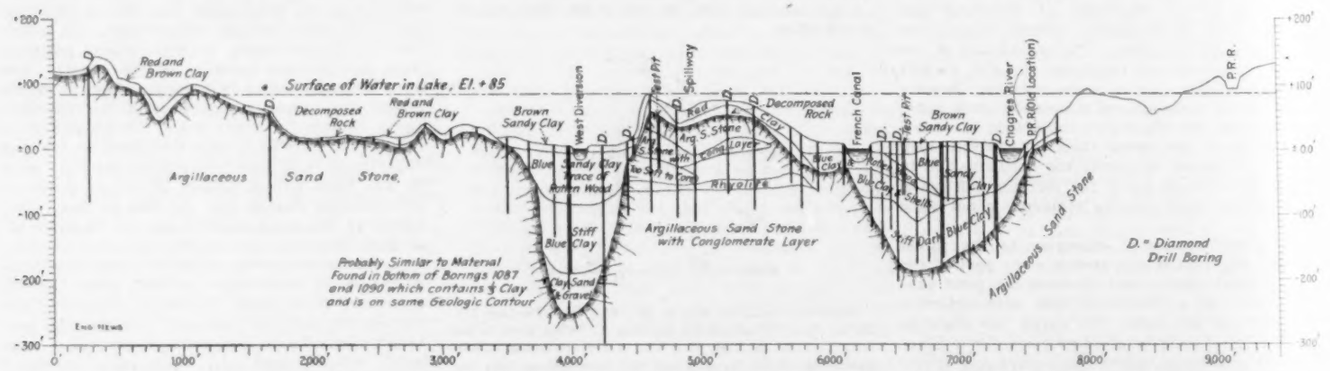
(3) The borings and excavation show no continuous layer of loose sand or gravel. No deposit has been encountered that appears sufficiently extensive and permeable to endanger the proposed structure when it is performing the functions for which it is designed.

Although this is the case, on account of the composition of the upper layer and the fact that it does allow some water to pass through it even at a very slow rate, it probably will be deemed advisable to drive a cut-off wall of sheet-piling through this material and across the valley. This will afford additional resistance and effectively prevent percolation. The above-ground conditions of construction can be watched and precautions taken. The underground conditions of foundation are determined only by deduction, and it is therefore the part of wisdom to err, if at all, on the side of conservatism.

The experiments with a model dam have demonstrated the feasibility of construction by pumping methods. The materials selected and taken from the locality previously determined upon have demonstrated their suitability to make a stable and satisfactory structure.

The packing and consolidation of the materials as laid down by the hydraulic process present so impermeable a structure that the resultant leakage can be considered negligible. The maximum rate, under conditions that probably never can obtain in the actual dam, was less than one-half gill per minute per horizontal linear foot of dam. If the proposed dam were similarly impervious and subject to similar conditions, the seepage per linear foot would be about two quarts in three minutes in the maximum section.

The results thus far obtained are from a type of dam laid down by the hydraulic process and allowing the material deposited at the down-stream slope to grade itself from coarse to fine on the water slope. In this form of construction practical conditions forbid the retention of the finer particles which tend to make the embankment the more impervious. On this account it is felt that the method usually employed in hydraulic-dam construction, i. e., depositing the materials on both faces and allowing them to flow toward the center of the dam, will be the most feasible in this case. This method will present a more stable upstream slope; it will be cheaper to build, as much more of the material pumped can be saved; and it will offer a much denser stop for the water, and thus undoubtedly reduce even the small amount of percolation that was obtained by the other method in the experimental dam.



PROFILE ON THE AXIS OF THE GATUN DAM DRAWN AUG. 26, 1908, SHOWING CHARACTER OF FOUNDATIONS.

The results of the investigations and experiments undertaken at Gatun show:

(1) That suitable material is available and near at hand for the construction of the Gatun dam by the hydraulic process.

(2) That the foundations are suitable for such a structure as the proposed Gatun dam if they are properly treated.

(3) That it is practically possible to construct a stable and water-tight earth dam at Gatun of the materials available.

(4) That the hydraulic method of construction, as proposed for this work, is feasible if proper conditions are observed.

EXPERIMENTAL HYDRAULIC-DREDGE-FILL DAMS AT GATUN, MADE FOR THE ISTHMIAN CANAL COMMISSION.*

By C. M. SAVILLE,† M. Am. Soc. C. E.

In order thoroughly to test the materials and methods available for the construction of the Gatun dam, experiments were made similar to those made at Clinton, Mass., for the Metropolitan Water-Works.

A large, water-tight, wooden tank was constructed having inside dimensions 75 ft. long, 6.08 ft. wide, and of height sufficient to take the proposed dam. This tank was set up on the bank of the Chagres River just north of the site selected for the dam. The elevation of the bottom of the tank inside was about 11 ft. above sea level.

In this tank the experimental dam was constructed entirely by hydraulic methods and exactly similar in shape to the proposed dam, but on a scale one-twelfth as large. It did not, however, seem necessary to include the whole of the long down-stream slope, and the tank was shortened 25 ft., corresponding approximately to 300 ft. in the original design. This made the hydraulic fill portion equivalent to about 885 ft. of actual dam. The height of the sides of the tank on the up-stream side for a distance of 22 ft. 8 ins. was 8 ft. 7 ins., or sufficient to allow a head of 100 ins. to be placed against the water face. From this point it ran upward on a 3 on 1 slope till it reached a height of 11 ft. 7 ins., sufficient to take a height of material corresponding to 135 ft. in the actual dam. The top of the sides was then run level for 9 ft. 3 ins. and then dropped on a 3 on 1 slope to a height of 7 ft. 10 ins., and continued on this elevation to the end. The outline of this dam is shown on [our] Fig. 1, and

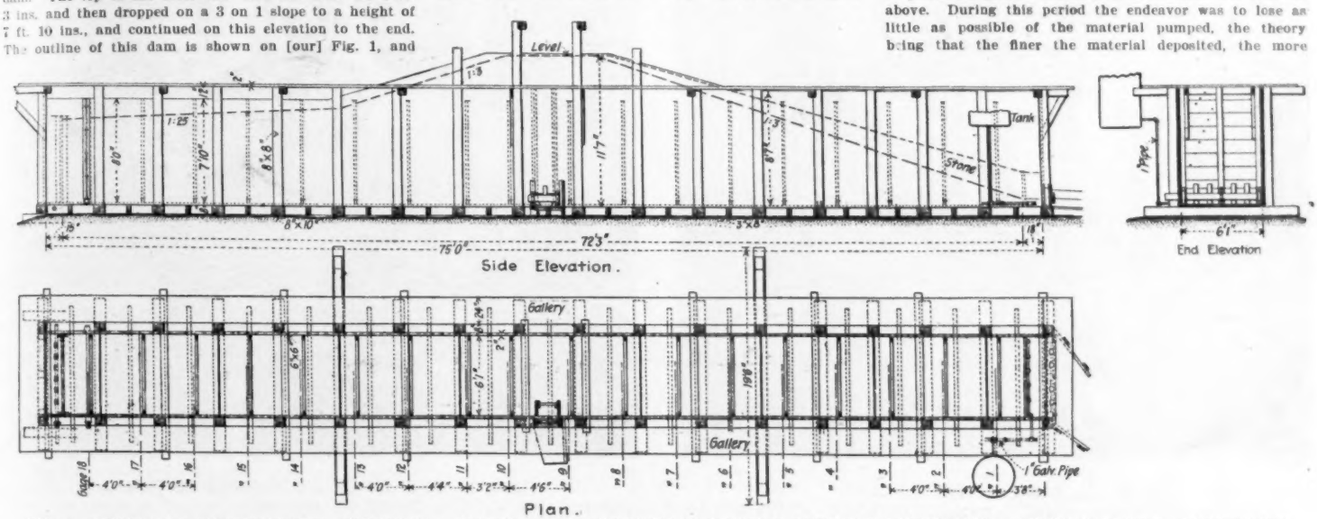


FIG. 1. TANK FOR EXPERIMENTAL HYDRAULIC -DREDGE-FILL DAM USED IN STUDIES FOR THE GATUN DAM, ISTHMIAN CANAL COMMISSION.

photographs of the tank are shown by Figs. 2 and 3. The material was all yellow pine lumber, the uprights being 8 × 8 ins. and the sides 2 × 12-in. stock. These planks had their edges slightly beveled, and all joints were tightly calked with oakum. On the inside, about every 4 ft., rough 2 × 4-in. scantling was placed on sides and bottom to make stops so that water might not find its way between the sand and the planking. After this, the entire inside was coated with pitch into which sharp sand was thrown to further improve the bond.

At intervals of 4 ft., 1½-in. galvanized-iron pipes perforated with ¼-in. holes were placed across the tank near the bottom, the ends being threaded and passed outside the tank. These pipes were covered with wire gauze, and later with a little fine gravel. The projecting ends of these pipes were held with lock nuts outside the tank, in order that caps and pipe might be screwed on without disturbing the pipe and its connection with the tank, and so cause leakage.

During the experiments the tank was absolutely tight. On the easterly side of the tank these pipes were capped so that they could be used for drainage, or for flushing out the pipes if they became clogged with sand. On the west side a tee branch was screwed in, and into the horizontal end was screwed a nipple with a cap on the end. Into the vertical opening was put a wooden reducer, and into this ½-in. gage glasses reaching to the top of the tank. These tubes were for the purpose of observing the slope of saturation in the material, and constant readings were taken of the elevation of the water by means of gage boards placed behind each glass. At the north or down-stream end of the tank was a portion about a foot wide partitioned off and forming an open space into which water could freely run from the sand in the dam. One-half-inch holes on 2-in. centers were cut in the partition and covered with netting to hold back any sand. Out of the open space a pipe was run to a measuring tank, and, after the experiments were begun, constant readings were taken of the amount of water percolating through the dam. The water against the face of the dam was kept at a constant height by overflows at different elevations, and a continuous flow of water maintained by feeding from an auxiliary tank. For the intake at the water face, precautions were taken to allow the water to flow in at the bottom, but in such a way that there was no danger of washing the material.

It was expected to build two types of dam; one with the material all delivered at the down-stream face and discharging over the up-stream slope, which would allow the material to grade itself from coarse to fine, the more impervious portions being placed on the water slope; the other type was that usually adopted in hydraulic-fill dams —that is, depositing the material on both slopes and allowing it to flow toward the center of the dam. On account of this design, outlets were arranged at both the up-stream slope and in the middle of the dam. The up-stream overflow had two openings, each 12 × 24 ins., while in the center the opening was 10 × 18 ins. After completion and during the time the water was against the dam, these openings were tightly wedged in place and calked to prevent leakage.

In order to take care of the overflow in the second type, it was necessary to construct a weir box on the inside of the westerly wall of the dam, and sliding boards were used to regulate the discharge. On the up-stream face cleats were nailed on a 3 on 1 slope, and in these could be dropped flashboards to hold back the water and regulate the discharge during construction of type I. In order to hold the water at any desired elevation, 1-in. pipes were run through the south or water end and capped. These pipes were at distances of 10 ins. apart, and the water could thus be held at any elevation by uncapping one of these pipes. Every 18 ins. along the bottom ½-in. holes were drilled on each side of the tank so that the material in the dam could be thoroughly drained. These holes were closed by wooden plugs during the tests. An observation platform was built around the top of the tank, and the whole was covered by a galvanized-iron roof to protect from rain and winds.

The pumping apparatus consisted of a 6 × 8-in. double, upright, reversible French engine which was taken from a crane that had been lying in the jungle for probably twenty years. This was belt connected to a 10½ × 8½-in. French centrifugal pump from one of the old ladder dredges found at Miraflores. This pump was bushed down to an 8-in. suction and a 6-in. discharge. This later was reduced to 4 ins. on entering the tank. The steam was furnished by two upright boilers also obtained from the jungle. Both of these were refitted, tested to 175 lbs. and run at 100 lbs. steam pressure.

The material came from an area at the end of Spillway Island, on the west bank of the Chagres. The area and location from which this was taken was chosen that it might be as nearly as possible representative of the materials to be subsequently used hereafter in constructing the proposed dam. The surface deposit was cleared off, leaving only a very thin layer of yellow loam and clay in which were some pockets of pure sand. Under this was a bed of compact blue sandy clay which formed the bulk of the material used. It was loaded into an old French coal barge, and towed to the pump at the dam. The pump suction was a flexible rubber pipe, and could readily be transferred into either of the two compartments into which the barge was divided.

After several trials, the best way to handle the material was found to be as follows: After the barge was moored in place at the pump, two 3-in. syphons primed by steam were placed over the side, and sufficient water continuously drawn from the river to keep the material in the barge in suitable condition for pumping. Four to six men shoveled the material into a wooden trough which was tilted under water to the suction pipe, and thus a constant supply was maintained. The discharge pipes were connected up with 4-in. flexible joints, and could be readily moved in any direction. On account, however, of the great velocity with which the water was discharged, it was found necessary to first discharge into a trough, which would reverse the flow, sending the water against the end of the tank. Here it was again reversed, and by this time had lost enough velocity to allow the materials held in suspension to settle into place. This difficulty, of course, will not be encountered in the actual dam, as the distance to the overflow will be so great. On account of delays occasioned by the non-arrival of lumber and other materials, the actual work of dam building did not begin until April 1 [1908]. As mentioned above, the material by this method graded itself from the coarsest portion at the down-stream end to the finest at the up-stream face. This material, which was a fine yellow silt, was very unstable, and had the consistency of a thick mud carrying considerable water. Some difficulty was experienced in making it hold to any slope under the wash of the discharging water. Boards, grass, burlap, and wire netting were all used to hold it in place and protect the slope as built from the overflow above. During this period the endeavor was to lose as little as possible of the material pumped, the theory being that the finer the material deposited, the more impermeable would be the up-stream face, and the pumps were run two minutes with a rest interval of five minutes. After several trials, this rate was found to give the best results, and the overflow was almost clean water. The velocity maintained on this tank and found to give the best results was about 2 ft. per sec. at the intake end. If at any time it appeared that a layer of silt wes being deposited over the down-stream portion, it was broken up by walking over with bare feet while water was discharging. For the first 25 ft. from the down-stream end, the material took a 1 on 50 slope, and for the next 5 or 6 ft., a 1 on 6 or 7 slope. All of this could be walked on immediately after the pumping stopped. The remainder of the material was a blue and yellow silt with very little sand and an almost flat slope. This settled very slowly, and when there was nearly 5 ft. depth in place, only 6 or 8 ins. was stable enough to support the weight of a man.

Samples of the material pumped were regularly taken in long glass tubes, but they varied greatly, due to the irregularity with which the pump was obliged to be operated. At the inlet the average of these samples in one hour's settlement was about 10% sand and about 70% clay and silt. After 24 hours they would show about 50% sand and 30% clay and silt. At the outlet most of the time the samples showed no sand and about 10% clay and silt after 24 hours' settlement. Thus it appeared that a great proportion of the material excavated was being saved.

On April 11 pumping was discontinued in order that the condition of the up-stream slope might be ascertained, as it was felt that its condition was not satisfactory. Samples of this portion would ooze out when the drainage plugs were pulled; this would dry in the sun and become almost stone-like. If placed in water, after twelve hours the pieces would lose their shape, and, if shaken, would discolor the water like mud. After examination, it was decided that too much of the fine

*From Appendix E., Report of the Isthmian Canal Commission for 1907-8.

†Assistant Engineer on Gatun Dam Investigations, Isthmian Canal Commission, Ancon, Canal Zone, Panama.

material had been held back and it was determined to remove the unstable portion.

Previous to this, however, on April 14, a quantity of the material was placed in four test boxes, two being filled with material from near the down-stream face and the other two from near the center of the dam. These boxes were 12 ins. wide, 14 ins. high, and 48 ins. long, and the bottom was covered with slats on which was placed mosquito netting. The samples taken from near the toe of the slope were almost pure clay and silt with no sand. Those taken from near the center of the dam had a considerable portion of very fine sand. On April 21 the boxes were tilted in order to give the material a chance to settle to a 3 on 1 slope, which it gradually did very slowly, although exposed top and bottom to the air. Cracks developed on the surface even while the center was wet. On June 5 the material had settled to about 70% of its former bulk, and had the consistency of freshly made cheese. Solid wood bottoms were now placed in the bottoms and made water-tight by pitching. Water was then turned on and a constant head maintained. On June 27 no change was found in the slopes which, previous to turning on the water, had been trimmed to a true 3 on 1 slope. The surface of the material for about 1/16-in. was unstable and muddy, but the remainder was firm and solid and had a greasy feeling to the touch. Evidently it was stable and thoroughly waterproof. On Aug. 1 this same condition was apparent, and there seems no question but what the material will not dissolve under the action of water similar to that to which it is here exposed.

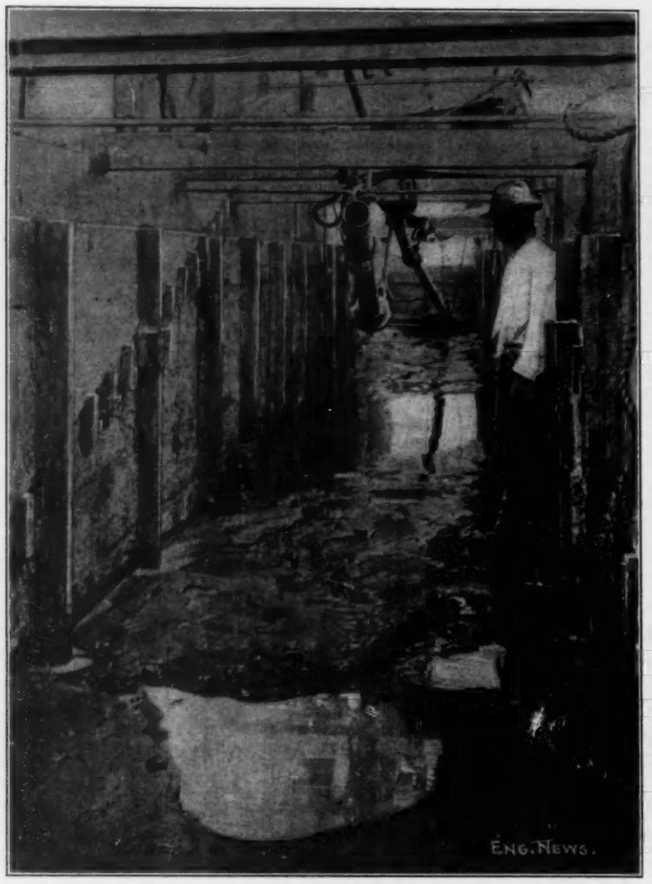
After the samples were taken, all the up-stream material from the center was washed out, leaving the solid material in the tank, as shown by the dotted line in Fig. 4 and marked "4/16/08." Similar material to that which had been previously used was again pumped in, starting on April 20. The attempt now was to retain only such material in the up-stream slope as was similar to that found in the center of the dam—clay and silt with some very fine sand—and it was now possible to walk over any portion of the dam almost immediately after pumping. Measurements were taken of the material in the dam and of that pumped from the barge, and it was found that about 40% of the amount pumped was actually deposited. The velocity in the tank was about 2 ft. per sec. over the entire length. On May 10 this dam was completed. The material on the water slope was now found to be in excellent condition. A layer of gravel 1 to 2 ins. thick was then placed on this face, and over this was placed a layer of crushed stone 4 ins. at the top and 24 ins. at the bottom. The dam was now allowed to drain for three days, and on June 14 water was admitted to the up-stream face at the rate of 1½ ins. per hour till it reached Elev. 18, and from there on it was raised at the rate of 1 in. per hour.

Continuous readings of gages and percolation tank were taken from the time the water was first turned on until the experiments were finished. The curves on Plates 109 to 119 [first and last, only, reproduced, as Figs. 5 and 6] show the rate at which the slope of saturation rose in the dam and Fig. 7 shows the seepage during the test. As the water was put on before the dam was thoroughly drained, it is very probable that some of the height shown in the earlier diagrams is due to water that had not drained out, rather than to seepage water from the up-stream slope. All of the curves show a marked change near the center of the dam. Referring to Fig. 4 and looking at the dotted line marked "4/16," it will be seen that the position of this distortion corresponds nearly with the slope on which the soft material was pumped out, as mentioned above. By studying the dotted lines on the plate and comparing with the next slope line taken in point of time, it appears probable that when the water was applied after washing out the soft material it first cut down the steep slope near the center of the dam. The fine material here was washed to the bottom of the tank and immediately covered with other material, until the whole slope was changed and upbuilding again began. The probability is, therefore, that along this portion the material was very much finer and more impervious, and the steepening of the slope shows what effect permeability may have on the hydraulic grade line. The variation in the points shown on Fig. 7 for the rate curve is undoubtedly due to carelessness in reading or in time of taking reading. Except two white men, all the help was black and of uncertain education and reliability. The results were checked each day by white observers, and during the last week, when the rate had become constant, two white observers took independent readings.

A head of 85 ins. was retained on the dam until the seepage had without doubt reached a constant quantity. In order to test the stability of the up-stream slope, the water in the tank was lowered 40 ins. in 52 minutes. The drainage of the slope was found to be perfect, and no tendency to slide was apparent.

In order to demonstrate that the water in the experimental dam was proportional to that which might be expected in a structure twelve times as large, the water against the dam was held for about a month at Elev. 45, or about one-half that previously used. Careful observations were taken, and the results are shown in Plates 121 to 130 [not reproduced, but see some of the curves on Fig. 15]. As expected, these results confirmed the belief that the variations in discharge were directly proportional to head and area.

In order to construct another model dam (called II) in the tank, it was necessary to get rid of the present materials, and they were washed out by a hose stream. During this operation it was found that the material was very solidly packed. Previously to the washing out test pits were sunk into the dam at intervals and samples obtained for mechanical analyses and porosity. On Fig. 8 is shown a section of experimental dam, Type I, contoured to show the distribution of material with reference to its effective size. The curve of saturation during period of maximum discharge is shown by the irregularly sloping line A-B. Its section of maximum



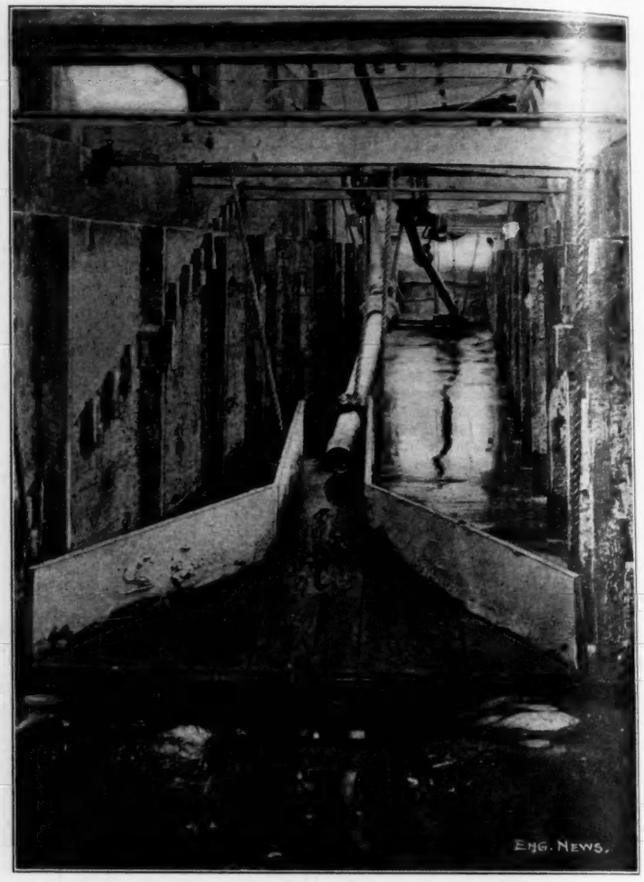


FIG. 2. TANK PARTLY FILLED. FIG. 3. METHOD OF DISCHARGING MATERIAL.
FIGS. 2 AND 3. INTERIOR VIEWS OF TANK USED FOR MODEL DAM TESTS AT GATUN.

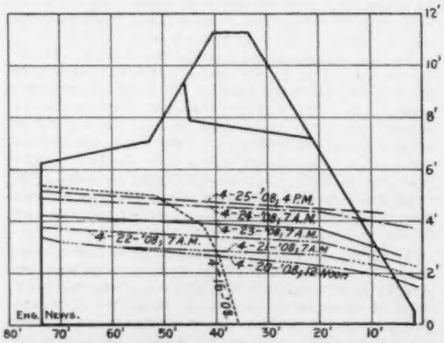


Fig. 4. Slope of Material in Experimental Hydraulic-Dredge-Fill Dam During Construction.

declivity as plainly seen to coincide with the fine materials left in the dam after the washing out mentioned. The line 5/18/08, Fig. 4, is reproduced on Fig. 8. The mechanical analyses of these samples are shown by Table I.

The clearness of the stratification in the model dam as exposed by test pits was very satisfactory, and the fact that the sides of the pit remained vertical for a week was evidence of the solidity of the structure. In flushing out finer and compact materials at the center took a slope of 1:15 or 1:18. The length of the pumping time varied as the embankment rose and the slopes narrowed in. In the first place, five-minute intervals were used, but at the last one-half-minute intervals were necessary. During these times the discharge through the weir box varied from 0.4 to 1.1 cu. ft. per min. The actual pumping time for discharging the first barge load was not taken, but the second, containing 52 cu. yds., was discharged in 236 minutes, or a cubic yard in 4½ minutes, and the third, containing 63 cu. yds., was discharged at the rate of 1 cu. yd. in 5 minutes. Much better time than this could have been made if it had not been necessary to consider the placing of the material in the tank. The distribution of the material is shown in Fig. 9.

Of the first barge load, 47 cu. yds., or 81% of the amount contained, was deposited in the embankment. Of the second, 34 cu. yds., or 65½%, was held, and of the third, 38 cu. yds., or 60% was retained. The gradual increase in the amount wasted is due to the narrowing of the dam cross-section as it approaches the top, and the necessity of keeping the proper grading of materials. It is seen, therefore, that by this method of construction about 70% of the material excavated was saved, against 40% retained in the case of the former dam. The percentage saved would have been larger in the case of type II, except that, in order to hasten the work, the embankment above Elev. 100 was pumped in almost continuously and much of the fine material wasted, as it was unnecessary to be particular with the portion above water level. Observations for seepage and saturation have not yet been begun in this type of dam on account of allowing the material in the center to drain and consolidate by settling. A comparison of the different methods used in building the two types of model dam showed:

(a) That the second method of construction was much the cheaper and quicker.

(b) No difficulty in retaining down-stream slope by method of central discharge in the second case, while in the first case it was almost impossible to hold it on account of washing.

(c) Relatively, the construction in the second case is much more impermeable, because so much greater a portion of the finely divided material is retained.

(d) In the construction by the first method, it seems impracticable to retain the finely divided materials, as they take the consistency of cream, tending to slough off and slide under their own weight. These materials are what make for impermeability, and the more that can be retained without danger from sliding, the more watertight the dam will be.

Under type II form of construction, the following are the conditions:

(1) An impervious dam of clay with some fine sand intermingled—a material which is almost impervious and not liable to crack and disintegrate.

(2) The dam supported on the down-stream slope by a more or less impervious material. The only function of this portion is to support the down-stream face of the clay dam and prevent sliding. If any water percolates through the clay dam, the material supporting is so fine next the dam that no clay can be washed away, but, by the grading of the material in the backing, freer and more free opportunity is given for this water to run away. Thus the slope of saturation in the embankment is lowered, and maximum use made of the rear portions to resist sliding.

(3) The material in the dam, although impervious, may be unstable under water and need support, except on a very flat slope. Here again on the upper slope the hydraulic grading comes into play. The finer material being next the clay dam and the coarser outside, maximum conditions of stability exist. The angle of slope in the clay would be very flat; in the sand it grows steeper

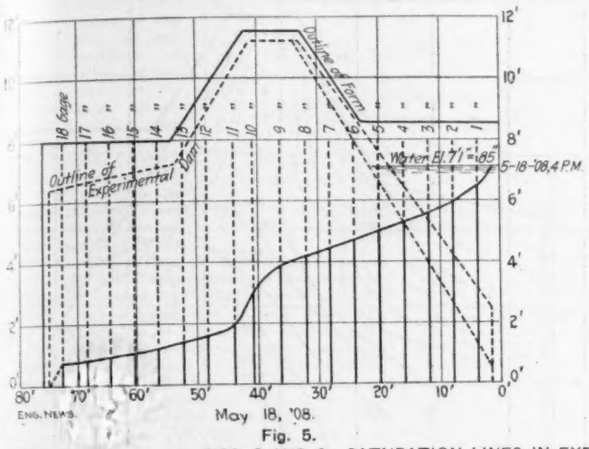


Fig. 5.

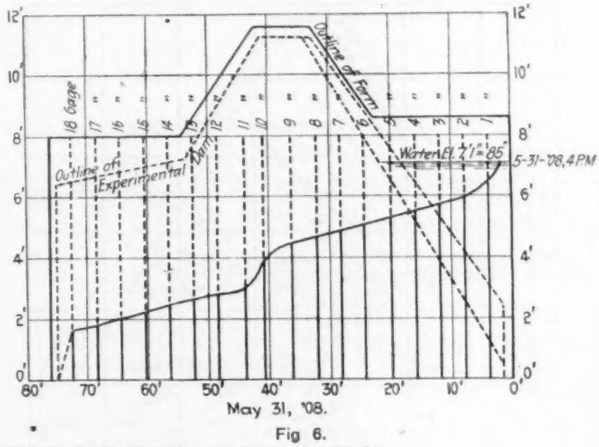


Fig 6.

FIGS. 5 AND 6. SATURATION LINES IN EXPERIMENTAL DAM, TYPE I., ON MAY 18 AND 31.

the material near the face it was necessary to cut furrows along the surface and gradually widen them, otherwise the hose stream only bored holes in the embankment. Back of the center line the method employed was to undercut, and when the mass dropped, break it up and wash it out. There was question if some water might not have found its way along the side or bottom of the tank in spite of the 2 × 4-in. water stops. This, however, was settled by the character of the material at the stops. These latter had acted as baffles and so greatly reduced the velocity that the finest materials had banked around the stops and here was the most impermeable place of all. As had been expected from the character of the saturation slope, much fine material was found concentrated near the bottom and at the center of the tank.

MODEL DAM II.

The general method of construction of this dam, as has been stated, was to discharge materials on both slopes and allow them to grade from coarse to fine from the outer slopes to the center. The inlet pipe was brought up over the center of the dam and discharged both ways in a manner similar to that previously described. The outlet was regulated by 6-in. stop planks in the weir box. The up-stream slope was easily regulated by 1 × 12-in. boards placed at intervals on the slope. It was apparent from the start that this type of construction was much to be preferred so far as ease in building was concerned.

The material for this dam was obtained in the same place and by the same methods as described for use in type I. Pumping began July 21, and the dam was completely finished Aug. 10. During construction deposits of silt left on top of the sand by the last of the draining could be washed off by pumping clean water for a very short time. Regulating to deposit sand or clay as desired could be done by placing the discharge end above or below the water surface. In this way sand could be deposited in slopes varying from 1:33 to 1:11, while the

TABLE I.—MECHANICAL ANALYSES OF MATERIAL USED IN EXPERIMENTAL HYDRAULIC-DREDGE-FILL DAMS AT GATUN.

Sample.	Elevation of sample from bottom, ins.	Classification. Per cent. by weight. Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt and clay.	Effective size* in millimeters.	Uniformity coefficient.†
A.....	12	5.0	20.4	42.0	9.0	23.6	0.018	8.7
B.....	12	2.0	14.0	31.0	10.0	43.0	.01	9.0
C.....	12	4.0	29.0	44.0	10.0	13.0	.028	7.1
D.....	12	.4	8.6	45.8	22.8	22.4	.02	6.5
E.....	12	1.4	18.0	52.0	10.6	18.0	.024	6.2
F.....	12	1.0	7.0	51.0	15.0	26.0	.019	7.4
A.....	45	.8	27.0	48.0	12.8	11.4	.04	4.8
B.....	45	.2	18.0	58.8	10.6	12.4	.035	4.1
C.....	45	.4	6.8	43.9	23.0	25.9	.012	10.4
D.....	45	...	3.8	37.4	31.2	27.6	.015	7.0
E.....	45	...	2.4	45.4	25.7	26.5	.015	7.2
A.....	74	7.2	11.2	39.0	10.6	32.0	.02	6.6
B.....	74	2.0	26.0	50.8	6.2	15.0	.025	5.2
C.....	74	2.2	16.6	55.6	13.6	12.0	.04	3.6
D.....	74	.6	10.2	43.6	17.4	28.2	.016	6.2

[*10% of the material of less and 90% of greater diameter. †Size at 60% point divided by that at 10% point.—Ed.]

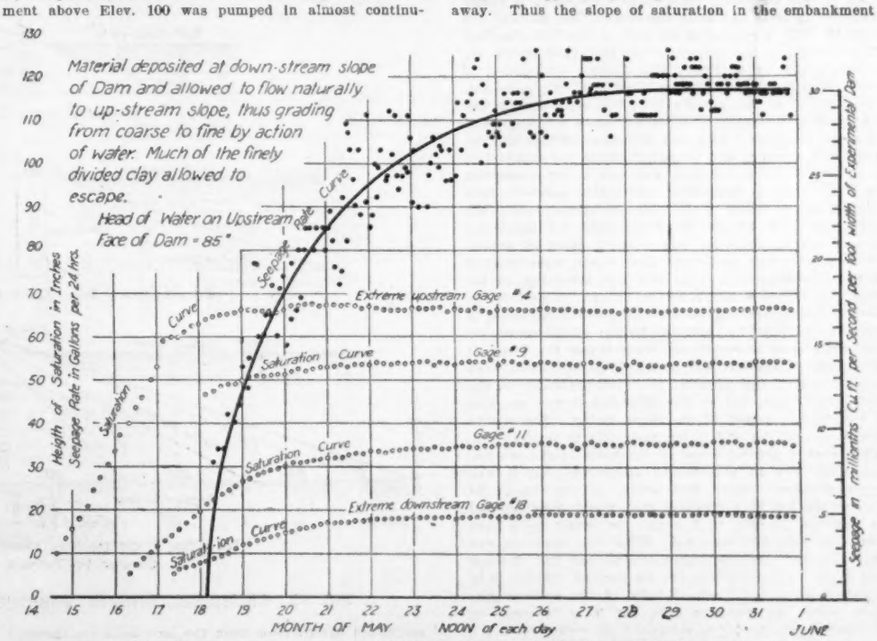

Material deposited at down-stream slope of Dam and allowed to flow naturally to up-stream slope, thus grading from coarse to fine by action of water. Much of the finely divided clay allowed to escape.
Head of Water on Upstream Face of Dam = 85'
Seepage Rate Curve
Extreme upstream Gage #4
Gage #9
Gage #11
Extreme downstream Gage #18
Saturation Curve
Height of Saturation in Inches
Seepage Rate in Gallons per 24 hrs.
Seepage in millionths Cu. Ft. per Second per foot Width of Experimental Dam
MONTH OF MAY
NOON of each day
JUNE

FIG. 7. SEEPAGE AND SLOPE OF SATURATION THROUGH EXPERIMENTAL DAM, TYPE I.

and steeper as it approaches the outer slope, where the sand is changed to gravel, and that to crushed stone. This latter material, which would stand on a very steep slope on account of its size, shape, and weight, is at an angle that would undoubtedly be considered safe for sand. The weight of the stone facing, and the graded materials back of it is, therefore, at its maximum for holding the materials behind in place, and for resisting any tendency in itself to slip and slide out. The fact that it is saturated with water is of no account, as it is not intended to be part of the impervious portion, but merely by its weight to support the clay dam which forms the water-tight portion. The difference between "puddle core" and "puddle face" is in name only. The "puddle core" dam is nothing but a "puddle face" protected from sliding, erosion and attacks of water animals by facing of more resistant and solid materials.

posed that shall be practically impervious. In the Gatun dam, on account of the methods to be employed, it will be possible to make this impervious portion many times thicker than is ordinarily deemed necessary in a puddle wall. In order to prevent any likelihood of such an occurrence as happened at Clinton, the up-stream face of this puddle wall is protected by a big sand bank and on the water face of this is to be placed a protective coating of the hardest and most durable rock to be found on the Isthmus. (Fig. 13.) Besides this protection, a solid barrier of rock and stone 60 ft. thick and 300 ft. wide is placed against the up-stream toe, and this will resist any sliding tendency which may have been overlooked or underrated in the slopes given to the dam.

is about 35 ft. per 100, and, with materials carefully selected, the slope may be 20 ft. per 100.

In all of these dams the slope of saturation seems greatly influenced by the permeability of the material in place on which the embankment is built. In the case of the Carmel dam, either the rock may have been slightly porous or the toe of the down-stream slope of such character that the water of percolation was led away as rapidly as it collected. In the case of the Middle Branch dam the material in the embankment was probably of sufficient porosity to allow the slope of saturation to cut the down-stream slope of the dam above the base line. In all other cases the materials below the dam probably were at least porous as those in the dam and allowed the water of percolation to run freely away. In Figs. 13 and 14 are shown lines of saturation, as indicated by borings and observations in the north and south dikes of the Wachusett reservoir, at Clinton, Mass. The utility of the core wall and its action in restraining the flow of water, is remarkably attested by these diagrams, which need no other explanation. These dikes are similar

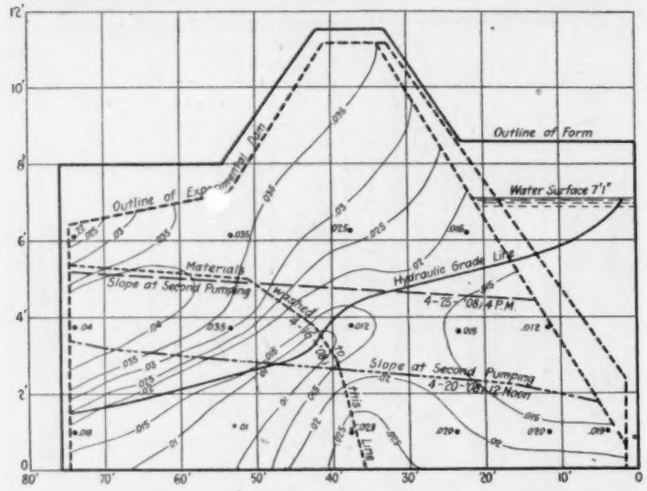


Fig. 8. Type I.

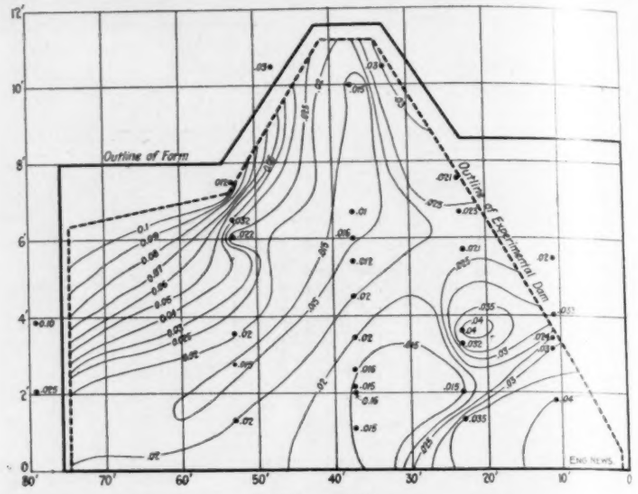


Fig. 9. Type II.

FIGS. 8 AND 9. EFFECTIVE SIZE AND RELATIVE DISTRIBUTION OF MATERIALS AS DEPOSITED IN EXPERIMENTAL DAMS, TYPES I. AND II.

Ideal conditions of this form of construction are shown in the section of the Necaxa, Mexico, dam in Fig. 10.

The prototype of the Gatun dam is said to be the dikes built at Clinton, Mass., as part of the Wachusett Reservoir, and, as considerable adverse criticism has been made of this structure, on account of a slide, it seems advisable to state the facts concerning this matter. On April 11, 1907, a portion of the face of this dam sloughed off and slid into the reservoir. On Fig. 11 is shown the maximum section of this slide, detailed description of which is given in Engineering News, Vol. 57, page 464. The material on the water side of this embankment was sand, but it undoubtedly contained some soil excavated from the reservoir. This was deposited without the extreme care taken in the "cut-off," where the material in 6-in. layers was rolled well wet, and every precaution taken to make a water-tight and stable barrier. How stable it was is shown by the steepness of the slope at the upper end from whence the bank slid. On the water face of the embankment was a thick layer of gravel. About quarter way down this slope was a berm or shelf in the embankment, and on this and extending up the slope was placed a heavy facing of rock to protect the earth embankment from wave action. When the water in the lake had risen to about the bottom of the stone facing, which also extended somewhat below the berm, it had saturated also the underlying bank. Of itself, even when saturated, this material was probably stable on the given outer slope, but in this condition it was not able to sustain the weight of the stone facing. The weight of this caused the underlying materials to squeeze out, and it took a natural slope, as is shown in the section. The affair was an unfortunate occurrence, but it was not a disaster. There was never, at any time, the slightest danger of a crevasse that would have allowed the water of the lake to flow out, nor would there have been if the lake had been full. While this condition was not, of course, expected, good engineering had dictated precautions to provide for the unexpected. While it is felt that the Gatun dam, if built of the section proposed, would be perfectly safe, yet it is intended to take all the precautions to safeguard the structure.

To this end, it is proposed to drive sheet piling into the ground underlying the proposed embankment, and carry them to such a depth that percolation here may be reduced to a minimum. In the embankment, itself, it is proposed to build an impervious core wall that shall also be as impermeable as possible. This, it seems, can best be laid down by the hydraulic process. This method is chosen on account of the materials available, and the climatic and labor conditions which forbid the ordinary puddled core wall. The experiments thus far show that a core can be laid down in water by the methods pro-

SLOPE OF SATURATION.

On Plate 136 [not reproduced, see Eng. News, Nov. 28, 1901, p. 413] are shown sections of dams and slopes of saturation found by borings made in the earth dams of the Croton drainage area by the board of engineers who examined the plans for the construction of the earth portion of the New Croton (N. Y.) dam in 1901. The slopes of saturation down-stream from the core walls are shown as follows:

	Feet per 100.
Bog Brook dam	30 to 40
Carmel dam	35
Middle Branch dam	21
Titicus dam	10.7
Amawalk dam	17 to 14.7

These slopes are much steeper than those observed in the experimental dam at Gatun, and are undoubtedly due to the materials used and the methods of construction. The board expressed that—the slope of saturation in the best embankments made of materials in the Croton Valley to the proposed Gatun dam, and the rate of seepage through them and the height and character of the saturation slope are most pertinent to this discussion.

When a dam is first constructed, then is the period, under ordinary conditions, of maximum saturation slope, and therefore maximum discharge. If at that time the slope of saturation cuts the down-stream slope of the dam at an elevation not higher than the point where the down-stream slope cuts the horizontal base line, the condition is one of safety. This statement is conditioned by the proviso that the foundation is stable. The experiments at Gatun seem to show that, as might be expected,

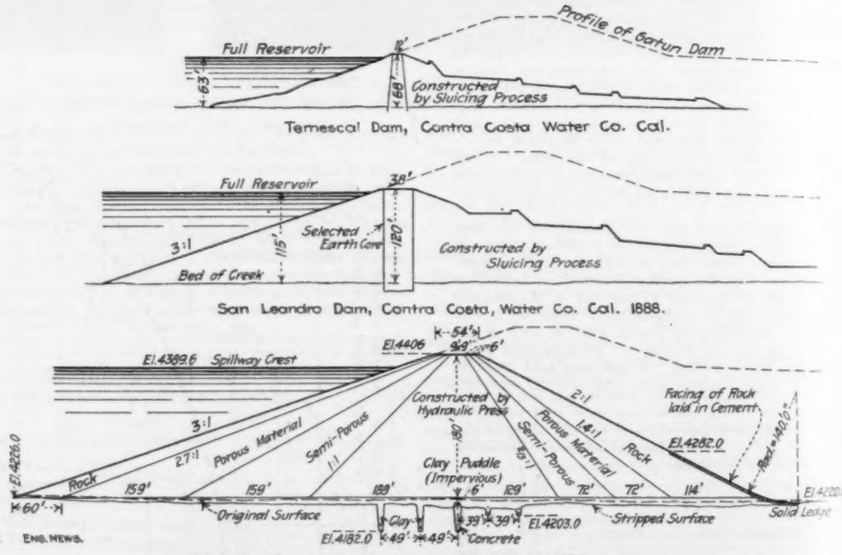


FIG. 10. CROSS SECTIONS OF VARIOUS DAMS BUILT BY SLUICING PROCESS.

When a dam is first constructed, then is the period, under ordinary conditions, of maximum saturation slope, and therefore maximum discharge. If at that time the slope of saturation cuts the down-stream slope of the dam at an elevation not higher than the point where the down-stream slope cuts the horizontal base line, the condition is one of safety. This statement is conditioned by the proviso that the foundation is stable. The experiments at Gatun seem to show that, as might be expected,

the hydraulic grade line up-stream does not begin at the surface of the water when the embankment is sloping, but begins at a point the elevation of which is equivalent to the total head less the head lost in forcing the water through the face of the embankment. As the up-stream slope is more and more compacted by the water, and as an impervious coating is found on the slope, due to the silt and other materials in suspension in the water, the elevation of this point grows less and less, the slope of saturation becomes flatter, and the discharge also becomes less. The dam is "silting up." The experiments on model dam, Type I (Fig. 15), show that this slope would have cut the base line at a point about 100 ft. up-stream from the point where the down-stream slope would have cut the base line. This condition would have been one of safety, and the probability is that additional security would have accrued as time went on. In the proposed dam, if the foundation were absolutely impermeable, the saturation line in time undoubtedly would cut the base line at its junction with the given down-stream slope. To do this the slope of saturation must flatten and the seepage decrease proportionately. From the seepage investigations it appears that the sandy clay layer near the surface is probably not much different in its transmission constant than will be the material in the dam itself. On this account the slope of saturation in a dam built similar to Type I, previously described, undoubtedly would cut the base line at some distance back from the slope of the dam. The location of this point will depend somewhat on the elevation of the ground-water table. Under this condition the dam would have ample security.

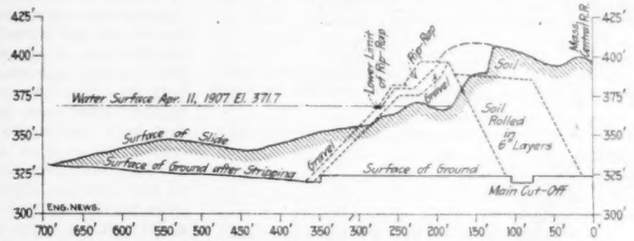


FIG. 11. MAXIMUM SECTION OF NORTH DIKE OF WACHUSETT DAM, MASSACHUSETTS, SHOWING SLIDE OF APRIL 11, 1907.

The total maximum rate of seepage through the model dam—Type I—under a head of 85 ins. of water was at the rate of 117 gals. per 24 hours, or

$$\frac{117}{7.48 \times 24 \times 60 \times 60 \times 6.08} = 0.00003 \text{ cu. ft. per sec. per lin. ft. of dam.}$$

Under a head of 45 ins. of water, the total seepage was at the rate of 37 gals. in 24 hours, or

$$\frac{37}{7.48 \times 24 \times 60 \times 60 \times 6.08} = 0.000009 \text{ cu. ft. per sec. per lin. ft. of dam.}$$

The head in the second case is but little more than one-half that in the first. The areas exposed to the water pressure also vary in about the same proportion. The slope of saturation in the first case is about double that in the second. From the above it appears in the second case, if the area exposed had been one-half and the pressure applied one-half of that used in the first case, the flow would have been about one-quarter, if the slope lines could have been continued to the base line in each case. The conditions then would be comparable. To compare results, refer to Fig. 15.

Case I.—45-in. Head.

AC = 2.79	Pressure on AB = AC − ½ AC = 2.50
AB = 0.58	Pressure on BC = ½ BC = 1.10
CB = 2.21	Using unit areas horizontally.
BD = AS = 65.0	(a) Area AB = AB = 0.58 sq. ft.
AE = 82	(b) Area BC = BC = 2.21 sq. ft.

To reduce these to an equivalent area having a slope

$$\frac{p}{1} = \frac{2.21}{65} = 1{:}29.4$$

(b) is already in this condition.

(a) $\frac{p}{1} = \frac{2.50}{65} = 1{:}26.$

To reduce these to an equivalent area having a slope

$$\frac{p}{1} = \frac{3.96}{56} = 1{:}14.1$$

(b) is already in this condition

(a) $\frac{p}{1} = \frac{GF}{KG} = \frac{4.75}{56.0} = 1{:}11.8$

(a) : (b) : : $\frac{1}{11.8} : \frac{1}{14.1} = \frac{14.1}{11.8} = 1.20.$

(a) = 1.58 × 1.20 = 1.89
(b) = 3.96 × 1.00 = 3.96
5.85 = Equivalent area under slope of 1:14.1.

Also, if the slopes had extended to "M," as the slopes are equal, the discharge would vary as the areas, therefore in the ratio $\frac{5.54}{5.85} = 0.95$, or the discharge at M would be 0.95 × that obtained at S.

Comparing now the above discharges and slope
Case I.—q = 0.97 × discharge at S. Slope = 1:29.4.
Case II.—q = 0.95 × discharge at S. Slope = 1:14.1

Discharges under the same pressure through unit area vary inversely as the lengths. Thus, unit area I : unit area II : : $\frac{1}{29.4} : \frac{1}{14.1}$, or in the ratio $\frac{14.1}{29.4} = \frac{1}{2.08}$; that is, the discharge per unit area of II is 2.08 times that of I. The areas of II and I vary as $\frac{5.85}{2.87} = 2.04$. Then the discharge of II should be 2.04 × 2.08 = 4.24 that of I. The increased discharge of I may be due to two causes: One, the water stops on the bottom which affect the area in I in greater degree than in II; and the other,

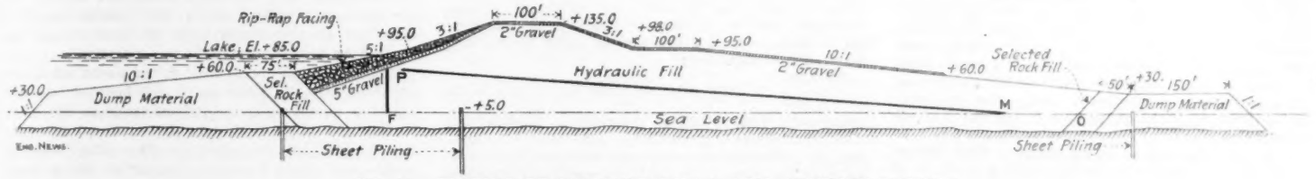


FIG. 12. OUTLINE OF PROPOSED GATUN DAM, MAXIMUM SECTION.

(P—M designates probable hydraulic grade line in Gatun Dam if built by hydraulic process with material discharged on down-stream slope, similar to Type I., Experimental Dam.)

The discharge per unit varies as the slope, therefore to reduce (a) to (b)

unit area (a) : unit area (b) : : $\frac{1}{26} : \frac{1}{29.4}$.

Multiply unit area (a) × $\frac{29.4}{26} = 1.13.$

(a) 0.58 × 1.13 = 0.66
(b) 2.21 × 1.00 = 2.21
2.87 = Equiv. area under slope 1:29.4.

Also, if the slope had extended to E, as the slopes are equal, the discharge would vary as the areas, therefore in the ratio $\frac{2.79}{2.87} = 0.97$, or the discharge at E would be 0.97 × that observed at S.

Case II.—85-in. Head.

FP = 5.54	Pressure on FG = FP − ½ FG = 4.75
FG = 1.58	Pressure on GP = ½ GP = 1.98
GP = 3.96	Using unit areas horizontally.
GK = 56.0	(a) Area GP = 3.96 sq. ft.
FM = 78.4	(b) Area GF = 1.58 sq. ft.

to the coarse material that was washed from the rear end of the tank and deposited in the front end just after the unstable material mentioned above was washed out, which would also have greater effect on I than on II. On this account it appears that it would have been better to have washed out all of the material at this time and started afresh with construction. If this had been done the slope line would undoubtedly have been nearer a regular curve slightly concave upward, and the probability is that the discharge in both I and II would have been reduced. A comparison of the outlines of the proposed dam and the model dam and reference to the slope of saturation shown in the model indicates that if the proposed dam were constructed by methods similar to those employed in model dam type I, but with a 3:1 slope on the down-stream side extending to the base, the leakage would probably be proportional to that actually found in model type I.

The Gatun dam has been estimated to be about 1½ miles long, but this length refers to the crest line, which is 50 ft. above the high-water line. In the main this dam follows ridges of hills in which the solid rock either outcrops or comes nearly to the surface. The dam is spoken of as being 135 ft. high and exposed to 85 ft. of water, but this is only in the maximum section, where

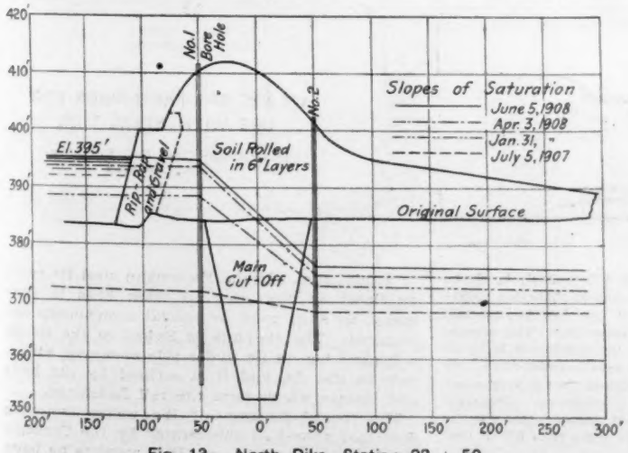


Fig. 13. North Dike, Station 22 + 50.

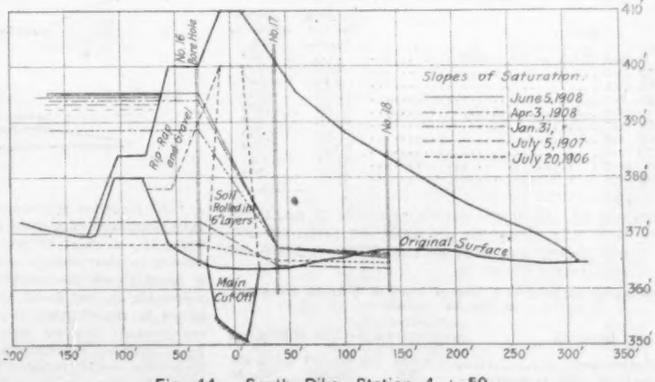


Fig. 14. South Dike, Station 4 + 50.

FIGS. 13 AND 14. HYDRAULIC GRADE LINES FOR DIFFERENT HEIGHTS OF WATER, NORTH AND SOUTH DIKES, WACHUSETT DAM, MASSACHUSETTS.

it crosses the valleys. Taken between the rock in the hillsides and excluding the masonry dam in the spillway, the actual length of the dam and the pressure against it are shown by the accompanying Table II.

The seepage in the model dam (Type I) was at the rate of 0.00003 cu. ft. per sec. per lin. ft. of dam. As the discharge varies as the areas under similar conditions, in the actual dam this seepage would be at the rate of 0.00036 cu. ft. per sec. per lin. ft. of dam of maximum section. If, now, the rock ridge in the hills were just as permeable as the built-up dam under the entire crest line, the seepage would be 0.00036 × 5,100 = 1.84 cu. ft., or 13.77 gals. per sec., and equivalent to about 5½ ordinary

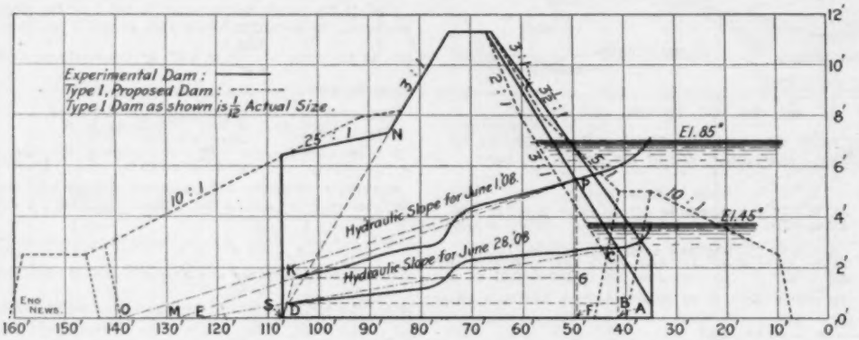


FIG. 15. SATURATION SLOPES IN EXPERIMENTAL DAM, WITH DIFFERENT DEPTHS OF WATER.

water pails full per second. This, however, is a condition based on a discharge if the dam were cut off at a point where the 3 on 1 upper slope on the down-stream side would intersect the base, and, under probable conditions, this would be reduced somewhat. If the rocks in the hills are also considered impermeable the seepage would probably be reduced about 25%. The total seepage therefore might be about 10 gals. per sec. A safe estimate therefore is 12 gals., or 1.6 cu. ft. per sec.

Below sea level the area in the gorges is about 384,000 sq. ft. This whole area, no matter what its depth, is, of course, exposed only to the pressure due to 85 ft. of water, and the length through which the water would have to percolate could be not less than the length of the hydraulic fill portion on the natural surface, say about 1,200 lin. ft. Neglecting now the frictional loss in forcing its way through the surface, and considering that the water pressure is applied directly to a perpendicular face immediately under the up-stream toe, and a discharge through a similarly perpendicular face 1,200 ft. north under the down-stream toe, we have 85 ft. of water applied to a section having an area of 384,000 sq. ft. and a thickness of 1,200 ft. This gives a hydraulic grade $\frac{h}{1} = \frac{85}{1,200} = \frac{1}{14}$, which, it will be noted, is about the same as that found for the conditions under 85 ins. head.

Assuming that the discharge was 0.00003 cu. ft. per sec. per unit width, an assumption entirely on the safe side, the height of the unit area is 5.54 sq. ft., and therefore the discharge per square foot $= \frac{0.00003}{5.54} = 0.0000054$ cu. ft. per sec. On this basis the total discharge under the dam would be 384,000 × 0.0000054 = 2.14 cu. ft. per sec. for the cross section below sea level. Dividing this amount by the area below sea level and the porosity (say, about 0.36), and bearing in mind that 0.25 ft. per sec. is said to be the velocity of current that will move clay, a figure is arrived at that seems to offer a reasonable factor of safety. Even if there were some coarser streaks that would let water through at a faster rate, there seems to be sufficient leeway on the side of safety.

	Cu. ft. per sec.
Above sea level	1.60
Below sea level	2.14
Total	3.74

86,400 × 3.74 = 323,200 cu. ft. per day, or about 2,500,000 gals. per day. This is on the basis that the entire valleys below sea level are porous and permeable, which is not the case. As the results of experiments at Clinton, Mass., Mr. F. P. Stearns* gives the accompanying table (III.), columns 2 and 4 being added for the purposes of this discussion:

$\frac{2,500,000}{700,000}$ = 35,700 gals. per 10,000 sq. ft. area in the actual dam. This, it will be observed, is somewhat less than for "fine sand" given in the table above. If, therefore, the entire superstructure and foundation were composed of fine sand, there might be expected the seepage estimated. The projected area of the dam above sea level is about 316,000 sq. ft. The analyses of the materials pumped into experimental dam (see Table I.) show that the effective size of the materials there correspond to the designation of "fine sand." The seepage investigations seem to show that the materials in the foundation are similar to those in the experimental dam.

Investigations of the conditions in the hills and valleys and in experimental dam, Type I., also giving consideration to the sheet piling to be driven across the gorges, and the reduction of seepage that will probably be shown in experimental dam, Type II., seems to show that 2,000,000 gals., or about 270,000 cu. ft. per day, is an ample amount to cover leakage at the Gatun dam. This amount is based on all the material in the foundation being as permeable as that found in the experimental dams. As shown by the analyses, the conditions give a very much exaggerated effective size and, therefore, discharge. Based on that determination, the seepage through the foundation would probably be not more than 5% of that given above.

*Trans. Am. Soc. C. E., Vol. XLVIII., p. 270.

TABLE II.—HEAD ON PROPOSED GATUN DAM AND LENGTHS OF DAM UNDER DIFFERENT HEADS.

Water.	Pressure, lbs. per sq. in.	Length exposed, feet.
0 feet (high water, +85')	....	5,100
10 feet	4.33	5,000
20 feet	8.46	4,800
30 feet	12.99	4,600
40 feet	17.32	4,300
50 feet	21.65	4,100
60 feet	25.98	2,700
70 feet	30.31	2,000
80 feet	34.64	1,600
85 feet (sea level)	36.81	500

TABLE III.—AMOUNTS OF FILTRATION IN GALLONS PER DAY THROUGH AN AREA OF 10,000 SQ. FT. OF DIFFERENT MATERIALS WITH A LOSS OF HEAD OF 1 FT. IN 10.

(Figures reduced to a loss of head of 1 in 14 are given in the last column.)

Material.	Relative permeability. Soil = 1.	Loss of head 1:10.	Loss of head 1:14.
Coarse sand	4,320	2,200,000	1,570,000
Medium sand	785	400,000	285,000
Fine sand	176	90,000	64,400
Very fine sand	14	7,200	5,100
Soil	1	510	360

A WEDGE RAIL FASTENING FOR STEEL TIES.

The rail fastenings used in connection with steel ties consist as a rule of some arrangement of bolts and clamps, the arrangement varying considerably in different makes of ties. A type of fastening which has been used extensively for many years abroad consists of a steel wedge or key driven horizontally between the edge of the rail base and a lug which is formed either upon the tie itself or upon a separate tie-plate. There may be either one or two wedges to each rail; in the former case one side of the rail base is held by a lug on the tie.

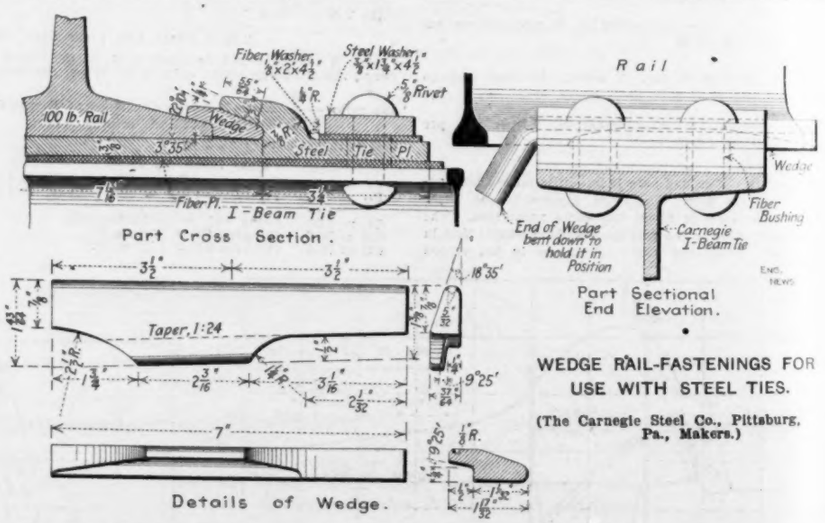
This wedge type of rail fastening has been adapted experimentally to the I-beam steel ties of the Carnegie Steel Co., which formerly have been fitted with bolted clamp fastenings, as described in our issue of Aug. 24, 1905. The new wedge fastening is clearly shown in the accompanying cut. This represents the construction employed where signal circuits require the insulation of the rails from the ties. The Union Ry., at Pittsburg, has 5,000 ties with these fastenings; on 1,000 of these the ties are insulated from the rails, while on the others no insulation is used.

It will be seen that the 100-lb. rail rests on a ⅝-in. steel tie-plate 14 × 4½ ins., which is secured to the top flange of the I-beam tie by four rivets. Lugs are formed on this tie-plate, and under each lug is driven a taper key or wedge of such shape as to bear upon the top and edge of the rail base. After the wedge is driven, its smaller end may be bent down (as shown) to prevent its working loose. In foreign practice this end is sometimes split so that it can be opened or spread for the same purpose.

The insulation consists of seven parts, all made of fiber: a ⅛-in. plate is placed between the tie and the tie-plate, two washers insulate the rivet heads, and four bushings (⅝-in. deep) insulate the bodies of the rivets. The fiber washer under the rivet heads is protected by a steel washer. Where no insulation is required, the tie-plate rests directly upon the tie, and the steel washer is omitted (together with the fiber parts). The rivet heads then bear directly upon the tie and the tie-plate.

The riveted tie-plate required with this new rail fastening adds necessarily to the cost of manufacture, and one important feature in the design of steel ties is to reduce the shop work to a minimum. In the Haarmann steel tie (with tie-plate) as now used on main lines in Germany, no shop work or special attachments are required. The tie-plate is locked to the tie by a hooked lug on its under side engaging with a hole in the tie, and it is secured by the bolts and clamps which form the rail fastenings.

The special features of the wedge fastening described above, as enumerated by the Carnegie Steel Co., are as follows: (1) it requires no bolts or clamps; (2) the width of gage can be varied



WEDGE RAIL-FASTENINGS FOR USE WITH STEEL TIES.

(The Carnegie Steel Co., Pittsburg, Pa., Makers.)

as required by wear; (3) neatness of gage can be obtained, even if the rail section is not exact; (4) greater resistance to shearing, as compared with bolts; (5) the fastening can be insulated; (6) it is impossible for derailed wheels to destroy the fastenings.

In 1907, an accident occured on the Pennsylvania R. R. in which some steel ties were damaged by (but were not contributory to) a derailment. This was noted in our issue of March 7, 1907, p. 264, where we reprinted the report of a committee of officials who after investigation exonerated the steel ties from responsibility, but remarked that none of the rail fastenings then in use with such ties were adequate for the requirements. In this accident, the pressure of the derailed wheels forced the rail outward by shearing the bolts. This pressure was transmitted directly to the bolt, and the only resistance to it was the bearing of the body of the bolt against the back of the hole in the tie. In many foreign designs of fastenings, and in the fastenings for the steel trough ties used experimentally on the Bessemer & Lake Erie Ry. (Eng. News, Nov. 5, 1903), a large hole is used, and receives a lug on the rail clamp, which thus relieves the pressure on the bolt and distributes it over a greater area. With the wedge fastening there is a still greater distribution of the pressure.

STORAGE OF COAL UNDER WATER AND TESTS OF THE WEATHERING OF COAL.

The storage of large quantities of coal for reserve or emergency supply is a necessity at many large industrial plants, and it involves important questions as to (1) the storage space and method of handling, (2) the possibility of fire due to spontaneous combustion, and (3) the possible loss of efficiency of the coal due to deterioration by exposure and weathering. Some particulars of experiments with the storage of coal under water at naval stations, etc., were given in our issues of July 5 and Aug. 23, 1906.

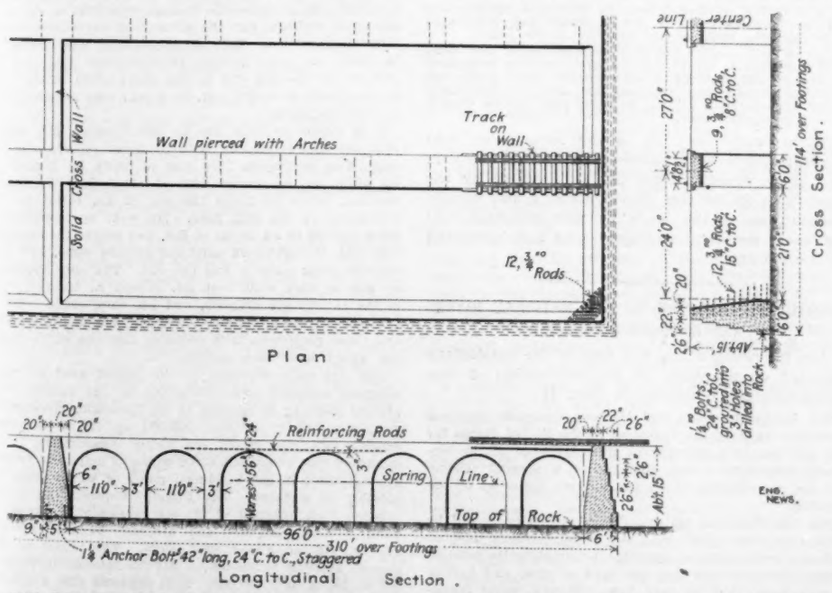
In the former issue mentioned above, there was a description of the adoption of this system at the new Hawthorne shops of the Western Electric Co., at Chicago. According to information furnished by this company, it carefully investigated (about 1902) the question of uncertainty of coal supply due to strikes and other conditions beyond its control, and decided to provide for storage of a considerable amount of fuel. Experience with coal bunkers at the Clinton St. plant has shown very clearly that the Illinois coals, when stored in ordinary bins exposed to the air, were very liable to spontaneous combustion. It was decided, therefore, to experiment with the storage of a large quantity of coal under water at the Polk St. plant. This was carried out with very satisfactory results.

When the large new plant at Hawthorne was built, it was decided to adopt the same system for coal storage. A large excavation or tank lined with concrete was built for this purpose within the company's property. The construction is shown on the accompanying cut. The size is 310 × 114 ft. over the footings, and 15 ft. deep. The interior is divided into three separate compartments by two solid cross walls. It is further subdivided by three longitudinal walls, but these are pierced with arches, and form viaducts carrying tracks for the coal cars. The longitudinal and cross walls thus form 12 compartments, each 96 × 21 ft. in the clear.

The side walls are battered on the inside and stepped on the outside, while the cross walls are battered on both sides. They are all anchored to the rock by anchor bolts, as shown. Horizontal diagonal reinforcing rods are embedded in the concrete at the corners of the outer walls. The longitudinal walls are 6 ft. wide, with arches of 11 ft. span, and they are reinforced by steel rods above the arches, as shown. Against each side, at the top, is a 6 × 8-in. timber, secured to the concrete with ¾-in. bolts. Track ties 7 × 9 ins., 7½ ft. long, are laid across the wall and have their ends bolted to these timbers. The engineers for this structure were E. C. & R. M. Shankland, of Chicago.

The coal may be delivered to or from cars standing on the three tracks crossing the storage pit or on tracks laid along each side of the pit. A Browning locomotive crane with grab bucket is used for handling the coal. This can unload six 40-ton cars per day, with the assistance of one trimmer in the car; and it can load eight 40-ton cars without the assistance of a trimmer. No switching is necessary in loading and unloading, as the cars and crane are on different tracks. Mr. G. A. Pinnock, Works Engineer, informs us that the ground is swampy, and the water rarely falls below 4 ft. from the top of the pit. In very dry weather, the discharge from a sump pump (which usually goes to a reservoir) is turned into the pit. Beyond this, the only provision for supplying water is a 12-in. cross connection with the reservoir. This is about 4 ft. from the bottom, and could be used also in draining the pit to this depth.

The total storage capacity is about 10,000 tons, and this reserve is maintained for emergencies. No provision is made for drying the coal before use, as it is believed that the handling of the coal will result in its being dry enough for all practical purposes by the time it reaches the boilers.



PIT FOR STORING COAL UNDER WATER AT THE HAWTHORNE (CHICAGO) PLANT OF THE WESTERN ELECTRIC CO.

Tests of the heating values of coal which had been submerged for two years and of similar coal which had been exposed to the weather in stock piles for the same length of time, were made recently by the Fuel Engineering Co., of Chicago. That which had been submerged showed 11,937 B. T. U., and that which had been weathered showed 11,710 B. T. U. In both cases, the coal had 15.9% ash, so that the results are directly comparable. Tests of the heat value of the identical coal when fresh are not available. The results indicate an economy, or a reduction in loss of efficiency, by storing the coal under water.

Tests of the effect of weathering on coal have been made by the Illinois State Geological Survey in co-operation with the Engineering Experiment Station of the University of Illinois. The results are given in a paper by S. W. Parr and N. D. Hamilton published recently in the "Year Book" of the Survey.* Samples of 100 lbs. each were obtained from various districts, and were stored for nine months under the following conditions: (1) outdoor exposure; (2) exposure to a dry atmosphere at a somewhat high temperature, ranging between 85° and 120° F.; (3) exposure at the same temperature, but coal drenched with water two or three times per week; (4) submerged in water at about 70° F. We give in the accompanying table some of the tests, the table being compiled from diagrams accompanying the paper. This shows very clearly the small amount of deterioration in the coals that had been submerged. The general statements of the experimenters, and their conclusions, are as follows:

The storing of coal is coming to be more and more a necessary practice in many industrial operations, and the question of deterioration enters as a very vital factor in the case. That such deterioration occurs is conceded by every one, but exact data as to its extent or information as to the conditions which retard or promote it are meager. Storage plants with capacities ranging from 50,000 to 150,000 tons are becoming frequent. Each per cent. of deterioration in a storage heap of the smaller size represents a loss of the equivalent of 500 tons of coal. This is a serious proposition if true, and the present series of experiments was devised for the purpose of developing, if possible, some of the facts connected with the matter.

Richter, after extended experiments in 1868, formulated an explanation (which does not seem to be disproved by more recent experimenters) to the effect that the weathering of coal is due to the absorption of oxygen. A part of this goes to the oxidation of carbon and hydrogen in the coal, and part is taken into the composition of the coal itself. We certainly need more definite information in order to formulate a final and satisfactory explanation of all the phenomena involved, but Richter's theory conforms to many of the known conditions and indicates the close relationship between the matter of deterioration and spontaneous combustion.

Conclusions.—(A) Submerged coal does not lose appreciably in heat value.

(B) Outdoor exposure results in a loss of heating value, varying from 2 to 8%.

(C) Dry storage has no advantage over storage in the open; except with high sulphur coals, where the high

*Illinois State Geological Survey; H. Foster Bain, Director, Urbana, Ill.

TABLE OF HEAT UNITS (B. T. U.) IN COAL AFTER EXPOSURE AND WEATHERING UNDER DIFFERENT CONDITIONS.

Time of exposure, months.	Conditions of exposure. Outdoor. B. T. U.	Dry, at 85° to 125° F. B. T. U.	Sprinkled, at 85° to 125° F. B. T. U.	Submerged. B. T. U.
A. Nut and Slack, Fresh, 14,400 B. T. U.				
3	14,200	14,050	14,180	14,400
5	14,050	13,800	14,000	14,400
7	14,150	13,875	13,950	14,400
9	14,025	13,900	14,025	14,400
B. Nut and Slack. Fresh, 14,450 B. T. U.				
3	14,375	14,150	13,900	14,400
5	14,310	13,975	13,600	14,350
7	14,230	13,920	13,400	14,300
9	13,700	14,025	13,320	14,320
C. Lump, Broken to Nut Sizes. Fresh, 14,050 B. T. U.				
3	14,080	13,950	.....	14,050
5	14,100	13,900	.....	14,025
7	13,950	13,820	.....	14,010
9	13,900	13,860	.....	13,980
D. Lump, Broken to Nut Sizes. Fresh, 14,930 B. T. U.				
3	14,450	14,550	.....	14,930
5	14,130	14,300	.....	14,930
7	14,025	14,260	.....	14,930
9	14,080	14,310	.....	14,930

disintegrating effect of sulphur in the process of oxidation facilitates the escape of hydrocarbons or the oxidation of the same.

(D) In most cases the losses in storage appear to be practically complete at the end of five months. From the seventh to the ninth month the loss is inappreciable.

(E) The results obtained in small samples are to be considered as an index of the changes affecting large masses in kind rather than in degree. But since the losses here shown are not beyond what seems to conform in a general way to the experiences of users of coal from large storage heaps, the results may be not without value as an indication of weathering effects in actual practice.

SCHEME OF THE BOSTON HARBOR TESTS ON THE EFFECT OF SEA-WATER ON CONCRETE.

In our issue of Nov. 5, p. 503, we published a letter from the Aberthaw Construction Co., of Boston, noting the proposed tests to be made in Boston harbor to determine the effect of sea-water on various kinds of concrete. The U. S. Navy Department has recently given the necessary permission for the tests and the Aberthaw Co. has prepared a set of specifications which are to be followed in the experiments. These specifications follow:

OBJECT.—The object of these tests is to determine what the action of sea water is upon concrete, both as regards climatic conditions and chemical action. The tests are to be made as nearly as possible in conformity with usual commercial work in order to be comparable in all respects with actual work.

HOW DONE.—The specimens are to be built in accordance with the requirements of the U. S. Navy Department and under their direct supervision, and in accordance with the following detailed specifications.

They are to be built in molds in the sea in such position as may be directed and exposed for easy inspection and for photographing. They shall be so marked as to be easily identified, and a careful record of the materials used and methods shall be kept for each specimen.

SPECIMENS.—The piers shall be made 16 ins. square and 16 ft. long, in such a position that the lower two feet shall be permanently immersed in sea water; thus it is improbable that the top will ever be immersed.

There are to be 24 piers, as follows: In the first series of nine specimens, a standard average composition Portland cement shall be used throughout which shall pass the standard specifications of the American Society for Testing Materials as required by the Navy Department.

No. 1 shall be made 1 part cement, 1 part sand, and 2 parts of stone. Mixed quite dry.

No. 2 shall be made of the same mixture as No. 1 mixed with sufficient water to make the concrete plastic.

No. 3 same as No. 1, but mixed very wet.

No. 4 shall approximate 1 part of cement, 2 of sand, 4 of stone, but shall be so proportioned after mechanical analysis of materials that the excess of cement over voids of sand shall be 10%, and the excess of mortar over the voids of the stone shall also be 10%. It shall be mixed quite dry.

No. 5, same proportions as No. 4, but mixed plastic.

No. 6, same proportions as No. 4, but mixed very wet.

No. 7, 1 part of cement, 3 of sand and 6 of stone. Mixed quite dry.

No. 8, same as No. 7, but mixed plastic.

No. 9, same as No. 7, but mixed quite wet.

No. 10 shall consist of a Portland cement which is free from iron. One specimen shall be mixed of the proportions 1:1:2, quite wet.

No. 11, same cement as No. 10, 1:3:6, wet.

No. 12, commercial Portland cement high in alumina, mixed 1:1:2, wet.

No. 13, same cement as No. 12, 1:3:6, wet.

No. 14, of a commercial Portland cement low in alumina, 1:1:2, wet.

No. 15, same cement as No. 14, 1:3:6, wet.

No. 16, of an iron ore cement practically free from alumina, 1:1:2, wet.

No. 17, same cement as No. 16, 1:3:6, wet.

No. 17, of slag cement, 1:1:2, wet.

No. 19, same cement as No. 18, 1:3:6, wet.

No. 20 shall consist of the same materials and proportions as given for specimen No. 7, but shall be most thoroughly well mixed (much better than commercial mixing), at the same time being quite wet.

No. 21 shall be the same as No. 7, except mixed with sea water, quite wet.

No. 22 shall be mixed of $^9/_{10}$ by weight of one part of standard Portland cement as No. 7, $^1/_{10}$ part by weight of hydrated lime, 3 parts sand, 6 of stone, mixed wet.

No. 23 shall be of materials given for No. 7, but in addition shall contain Sylvester mortar hereinafter described, mixed wet.

No. 24 shall be of materials in No. 7, and in addition shall contain 5% by weight of the cement of finely pulverized clay; to be mixed wet.

In addition, there shall be 15 cubes of 8-in. on each side, of 1 part standard Portland cement, 1 part sand, 2 stone; and 15 others of the same cement, mixed 1:3:6. One-third of these after being thoroughly set shall be permanently immersed in water; another third shall be supported at about half tide; and the rest shall be kept permanently dry, but exposed to the weather.

There shall also be made briquettes of the same cements and proportions of mortar as above described for concrete of such number that they can be tested at intervals covering a period of years, some of which shall be kept in the laboratory, some exposed to the same conditions that the cubes will have; and enough briquettes shall be made of standard sand to compare the relative strength between standard and the materials actually used.

TEST OF MATERIALS.—All cement shall be thoroughly tested for all physical properties and shall be subjected to chemical analysis. The sand shall be subjected to a thorough mechanical and physical analysis to tell the relative sizes of its grains and the amount of foreign matter which it contains, if any. The same tests shall be applied to the stone. The various ingredients, such as sea water, hydrated lime, Sylvester mortar, and clay, shall be tested that the exact nature of the material may be known.

SAND.—The sand shall be of a good quality, commercial bank sand, clean, coarse and sharp, as free from all impurities and foreign matter, as can be obtained commercially. The stone shall be of trap rock which shall have passed a 2-in. ring and have been retained on a ½-in. ring. It shall be as free from dust and dirt as commercially practicable.

MIXTURES.—All materials shall be proportioned by volume as given above for each specimen. A cubic foot of cement shall contain 100 lbs. by weight. The sand and stone shall be measured on the basis that a barrel of cement contains 380 lbs. net and measures 3.8 cu. ft. Samples of the sand and stone shall be weighed so that the proportion by weight (as well as by volume) will be known.

The amount of water to be used shall be accurately measured for each batch, and shall be so proportioned by experiment that the dry specimens shall just fail to show moisture when tamped in place; the plastic specimens shall just barely begin to quake when tamped; and the wet specimens shall be so proportioned that the mortar will flow easily off the blade of a shovel and shall be wet enough to flow readily into place without being spaded or tamped.

The Sylvester mortar shall be mixed as follows, as given in Gillette's Hand Book on Cost Data, pages 389 and following: A light colored soft soap shall be dissolved in water, 1¼ lbs. to 15 gals. of water; 3 lbs. of powdered alum shall be mixed with each bag of cement. After all the materials of the concrete are thoroughly mixed dry, water containing the soap in solution shall be used to mix the materials wet to the proper consistency.

MIXING.—All materials shall be thoroughly mixed in a batch concrete mixer of approved type. They shall be fed into the machine as quickly as possible and shall remain for two minutes after the last ingredient is added. For the specimen which is to be extra thoroughly well mixed, the material shall remain in the mixer for twelve minutes.

If the weather be cold, all frost shall be removed from the sand and stone by heating before the materials are placed in the mixer.

PLACING.—The concrete after mixing shall be placed in the form as quickly and continuously as possible, and after proper tamping shall not be again disturbed. In no case shall concrete which has been allowed to stand for more than ½ hour be used, and in no case shall a half hour elapse between placing two batches of concrete in the same mold.

FORMS.—They shall consist of planed and matched spruce lumber so that the forms may be as tight as possible, and shall be so thoroughly braced as not to spring under the pressure of green concrete. The forms shall be left on for such a length of time that there shall be no damage to the concrete when they are removed. The Inspector shall be judge as to when it is proper to remove forms.

REINFORCEMENT.—Columns shall be reinforced with embedded steel bar about ⅝-in. square, which shall be bent into a U-shape and run throughout the length of the big specimens near two diagonally opposite corners and the loop shall project a sufficient distance above the top of columns to permit of their being easily hooked in case it is desired to remove them.

A hole 3 ins. in diameter shall be cored in the upper eight feet of each specimen to permit of examination from time to time to see if water has penetrated through the walls of the concrete to the hole.

PROTECTION.—After the specimens are cast, they shall be protected as far as possible from freezing until they have set for a period of at least five days, and after the forms have been removed they shall be thoroughly and substantially braced, so there shall be no danger of their tipping over.

Many suggestions as to the manner of conducting these tests have been incorporated in the above specifications, but it is hoped by the projectors of the test that criticisms and recommendations of the work as now proposed will be freely made by engineers who are interested in the results.

RESOLUTIONS ADOPTED BY THE NATIONAL RIVERS AND HARBORS CONGRESS.

The following is the full text of the resolutions adopted at the close of the convention of this association at Washington, Dec. 11:

The National Rivers and Harbors Congress approves the plan urged by the President of the United States for the creation of a commission or department of the National Government that shall adopt a general scheme for the conservation of all the natural resources of the country.

But this Congress realizes that of necessity it will be some time before such plan can be legislatively adopted and the commission or department formulate its detailed policy, and believing that the need of river and harbor improvement, that we may have adequate water transportation, is imperative, and realizing that there are now a number of river and harbor projects sufficiently matured and the need for which is so pressing as to warrant the Congress of the United States in immediately bringing about their adoption and completion, it is the sense of the National Rivers and Harbors Congress that:

First: The Congress of the United States should at its present session authorize the issuance of bonds of the government to an amount of $500,000,000 to be sold from time to time, in such quantities as may be necessary, the proceeds of same to be used in the payment exclusively of such river and harbor work as shall be authorized by Congress; the provisions for the issuance of said bonds to be similar to those authorizing the bonds for the construction of the Panama Canal.

Second: We further urge that the Congress at this session authorize the completion of such river and harbor projects heretofore entered upon as are of such a character as to surely fit into and carry into effective use any larger, comprehensive and connected waterway system that may be subsequently adopted.

Third: That Congress also adopt such new projects as are of a like character as those just mentioned.

Fourth: We further recommend the appointment by the President of this organization of a committee of five, of which he shall be a member, to prepare a bill for introduction in the Congress of the United States, for providing for the bond issue above set forth and the creation of a statutory commission to study the waterways of this and foreign countries and suggest to Congress in a full and detailed report a comprehensive plan and policy for improving our waterways.

Fifth: We further urge that the Corps of Engineers, U. S. Army, should be at least double its present size, utilizing in the permanent organization as far as practicable the present U. S. Assistant Civil Engineers, and that the Corps of Engineers be given authority to formulate and propose to Congress plans and projects for river and harbor improvement.

FIRE IN THE U. S. GEOLOGICAL SURVEY BUILDING AT WASHINGTON.—(From the Washington Correspondent of Engineering News.) What might have been a very serious fire took place in the Hooe Building, 1324 F St., N. W., Washington, occupied by the United States Geological Survey, on the night of Tuesday, Dec. 16. The fire was confined to the fifth and sixth floors, where considerable damage was done and it was feared at first that many valuable records, maps and manuscripts were destroyed. A careful inventory, however, has been made since the fire and it has been found that while the damage was really great, amounting in all to about $30,000, still nothing was destroyed that was really irreplacable or that would take a long time to restore. Most of the damage was done in the topographic division on the fifth floor, where many maps and old records were destroyed, none of them, however, of great value.

It is a fortunate thing that last spring the head of the topographic division prevailed on the Director, Mr. George Otis Smith, to have installed five large fireproof safes, in which it is the custom to place all the valuable papers and records, including maps in the process of being drawn and field-notes. Had these papers been lying around as they were at night prior to the purchase of the safes, they would all have been burned and practically a whole season's work lost. It was at first reported that considerable damage was done to the Conservation division, but the subsequent inventory showed that comparatively little of importance was destroyed. In fact, the most serious inconvenience that will be suffered by the fire will be the interruption in the work of the divisions burned out, as it will take several weeks to refit the floors.

It is almost entirely due to the Director, Mr. Smith, that the entire building with priceless records was not completely destroyed. He was at work by himself in his office on the second floor at about 8:30 Wednesday evening, when he heard the cry of fire raised by the watchman on the fifth floor. He went up immediately, after turning in an alarm of fire, and fought the fire himself with extinguishers until the firemen came, and then assisted them until it was put out. The only assistants he had to start with were Dr. Joseph A. Holmes, chief of the technologic division, and his chief clerk. Had it not been for the prompt and efficient work of the Director and these gentlemen it is probable that the entire building would have been gutted.

This fire calls attention to the urgent need for more adequate and safe accommodations for the Survey. The present building is believed to be thoroughly fireproof in structure, but it contains 103,000 sq. ft. of varnished wooden partitions which are highly inflammable. It is estimated that about $4,100,000 worth of maps and records are contained in the buildings, many of which could not possibly be replaced. The Director requested an appropriation from Congress at the last session of $1,500,000 to build a new, adequate and fireproof building for the Survey, but no action was taken. The rental on the present building is $35,000, while the interest on $1,500,000 at 2% is only $30,000. It is expected that a bill for a new building will be presented to Congress this session and it is to be hoped that it may be passed and the valuable records of the Survey made safe from fire.

A HEAD-ON COLLISION of two freight trains on the Canadian Pacific Ry. at East Richford, Vt., Dec. 16, demolished both locomotives and six cars. One man was killed and four others injured.

A COLLISION IN THE POUCH TUNNEL between Limoges and Brive, France, Dec. 16 resulted in the death of 15 persons and the injury of 30 others. The wreckage

of the two trains (a freight and a passenger) caught fire and the rescue work was made difficult by smoke and heat.

TWO PASSENGER TRAINS on the Cleveland, Cincinnati, Chicago & St. Louis Ry. collided head-on between Lilly and Woodruff, Ill., Dec. 17. Both engineers were injured, one fatally. The accident occurred during a dense fog.

A POWDER MILL EXPLOSION in the glazing mill of the Senior Powder Co., one mile north of Morrow, Lebanon Co., Ohio, Dec. 18, wrecked the mill and killed two men.

A THEATER FIRE during a performance, but without fatal results, occurred in New York City on the evening of Tuesday, Dec. 22. The Herald Square Theater, Broadway and 35th St., was found to be on fire at about 11 p. m., near the end of the performance. Audience and company left the building quickly, but without panic. The fire destroyed some offices behind the balcony, and damaged the balcony floor and the roof, in which it spread. The stage space was not affected. The chief feature of the fire was the fact that the theater entrance and lobby through which the larger part of the audience made its exit were directly under the burning office rooms.

EARTHQUAKES IN MONTANA were reported during several days of the week, chiefly on Dec. 20 to 22. Virginia City and the region around Crater Lakes, an extinct volcanic region, report the most severe effects.

THE COLLAPSE, DURING CONSTRUCTION, of a span of a bridge across the Potomac River at Williamsport, Md., Dec. 16, 1908, caused the death of five workmen and injured four others. The bridge is to be 1,600 ft. long and consists of a number of steel girders resting on high, slender concrete piers, built without reinforcement. At the time of the accident the erectors were placing, from a traveler, one of the spans on the concrete piers and, either from some defect in the traveler tackle or owing to weakness of the supporting concrete, the whole span dropped, carrying down with it into two feet of water a number of workmen and the traveler. In the coroner's inquest there was testimony to the effect that the concrete on the pier was only about a week old and apparently not yet entirely hard. This testimony was contradicted by the engineer in charge. Suspicion was also cast on the swivel-ring of the erecting derrick which was found fractured partly apparently from an old break. The jury brought in the following verdict:

> The accident was caused by the constructors of the piers being permitted by the engineer to use a grade of sand inferior to that provided for in the contract and in authorizing or permitting the structural iron work and traveler to be placed upon pier No. 10 while it was yet too green to be used for that purpose.

The accident is to be investigated further.

FOUR OF THE PENNSYLVANIA CAPITOL CONSPIRators, who were convicted last March of defrauding the State, were sentenced on Dec. 18 to two years in the penitentiary and $500 fine each. Those sentenced are the former State Treasurer, the former Auditor-General, the former Superintendent of Public Grounds and Buildings and the contractor for the furniture.

THE LAST WIRE IN THE MANHATTAN BRIDGE cables was strung on the afternoon of Dec. 10. The 37,888 wires of the four cables have thus been placed in four months. The construction of the suspended foot-bridges used in the cable-spinning was begun on June 15, 1908 (E. N., June 18) and the stringing of the wire for the permanent cables was begun early in August (E. N., Aug. 13, 1908). The work of compressing and binding the cables and attaching the suspender clamps and ropes will consume two or three months more, but in the meantime the erection of the suspended trusses will be begun by placing the sections at the towers. The Glyndon Contracting Co. erected the cables, for the Carbon Steel Co.; the wire was drawn by the J. A. Roebling's Sons Co. The general contract for the superstructure is held by the Ryan-Parker Construction Co. The Terry & Tench Co. will erect the suspended structure.

A RECORD IN RAPID-TRANSIT MOVEMENT was made on the elevated and subway lines of Manhattan borough, New York City, on Monday, Dec. 21. The total number of passengers was 1,800,000. Of this number the four elevated lines transported slightly under 1,000,000, while the subway, equivalent to two lines, moved about 800,000.

TRAFFIC RECEIPTS ON THE WILLIAMSBURGH Bridge during the past four years increased from $50,000 in 1904 to $153,000 in 1907. The maintenance costs have been less than the income in all cases. Elevated trains began running over the bridge in 1908, so that the receipts for this year will probably be much larger than those of 1907.

A SPEED-CONTROL BLOCK SIGNAL SYSTEM has been developed by the Interborough Rapid Transit Co. for the New York subway, and having been installed at the south-bound entrance of the 96th St. station for some months past it has proved highly successful, and has obtained the approval of the Public Service Commission. With the ordinary arrangement of signals, this station could pass only 28 to 30 express trains per hour in one direction under rush-hour conditions, i. e. the trains were spaced 2 min. apart, but with the new installation a rush-hour spacing of 1 min. 32 sec. has been attained under favorable conditions, or 39 trains per hour.

The system consists of a succession of signals, spaced much more closely than the regular block signals, which are so interconnected that any given signal cannot go to clear until the expiration of a fixed number of seconds after the train has passed the signal next back of it. This means that the train must occupy a fixed period of time as a minimum, in passing from one signal to the next ahead; in other words, its speed may not be greater than a predetermined limit. There are five or six of these approach signals, spaced 100 to 200 ft. apart; they are timed for a speed of 8 mi. or less per hour at the station end and a somewhat greater speed at the upper end. Their effect is to permit a train, while waiting to enter the station track, to approach within a few feet of the crossover switch which forms the station entrance, without violating the safety condition that every red signal (by means of its automatic stop trip) will bring a disregarding train to full stop before it could reach the train or switch protected. Under former conditions a waiting train was held far back of the station, as the stop signal had to be a distance back equal at least to the braking distance for full running speed. When the station track was cleared, the waiting train would lose a large fraction of a minute in moving over this distance, whereas these delays are saved under the new system, by permitting the waiting train to approach close to the station provided it moves at very slow speed. All these approach signals, of course, are fitted with automatic stops. The last signal, controlling entrance to the station track, is not part of the approach system, but is set by the interlocking machine which protects the crossover switch.

Fuller details of the arrangement and mechanism of the signals are not yet obtainable. The present intention is to apply the new system to the entrances of all express stations of the entire subway, on both north and south-bound tracks.

THE WRIGHT AEROPLANE, operated by Mr. Wilbur Wright at Le Mans, France, made a new record for duration of flight, of 1 hr. 53 min., 59 sec. This exceeds the record made on Sept. 21 by 22 min., 8 sec. It will be remembered that about 40 minutes of the earlier flight were made after dark which fact reduced the record by that amount if considered in the competition for the Michelin cup. The average height attained in the last flight was 24 ft. The official distance was 61.5 miles, but this does not include the additional length of sweeps and wide turns. The maximum height reached was 360 ft., which figure is also a new record.

THE WALNUT LANE BRIDGE across the Wissahickon in Philadelphia was formally opened for travel on Dec. 16. The ceremonies, which were in charge of a citizens' committee, comprised the transfer of the structure from Mr. Riddle, of Reilly and Riddle, its contractors, to Mr. Geo. S. Webster, Chief Engineer of the Bureau of Surveys, and from Mr. Webster to Mayor Reyburn of the city. The bridge, which has been described several times in Engineering News, contains a span of 233 ft., the largest concrete arch in this country at this time, although there has recently been completed in Canton Appenzell, Switzerland, a concrete arch of 259¼ ft. span.

A LARGE INCREASE IN IDLE FREIGHT CARS took place in the two weeks from Nov. 25 to Dec. 9, according to the latest report of the Car Efficiency Committee of the American Railway Association. The total surplus on the latter date was 175,643 cars (against 132,829 on Nov. 25), an increase of 42,814. The increase was about equally divided between the two important classes, box cars and gondola cars. The chief increases are reported by the Middle Atlantic and Great Lakes states, as far west as the Dakotas, and the Pacific Coast states. The shortages which have prevailed in some sections for two months past have practically disappeared, the present figure of 1,679 representing a decrease of 7,600. On the other hand, cars in shop have continued to decrease, the decrease for the two weeks being about 10,000. Thus the aggregate change in the car situation is an increase of about 30,000 in the number of idle cars. The present total is the greatest since early in September. The low point was reached in the middle of October, when the idle cars were reduced to about 100,000. However, the present surplus amounts to only 8% of the total number of cars owned by the American and Canadian lines, and the sum of idle cars and cars in shop is probably not over 15% of the total stock of cars.

A BRIDGE ACROSS THE HUDSON RIVER at New York City is the subject of an engineering report made by Boller & Hodge to the Interstate Bridge Commission, a joint commission of the States of New York and New Jersey appointed by the legislatures of these two States for the purpose of reporting on the practicability and cost of a Hudson River bridge. The consulting engineers found three promising sites (N. B., promising as to feasibility of constructing a bridge; the need for such a bridge, or the relative traffic value of the different sites, is not discussed), namely at 57th St., at 110th St., and at 179th St., New York City. A bridge at 57th St. is proposed by the North River Bridge Co., which has a charter for a bridge at this point; it estimates the total cost, including right-of-way, damages, approaches, etc., at about $70,000,000. This plan is for a suspension structure of unprecedented span (3,200 ft.). The consulting engineers for the Commission, omitting the subways and some other features proposed by the company, and making no provision for steam railway tracks, make an estimate of $30,000,000 for comparison with the costs at the other two sites. At 110th St., a cantilever bridge of 1,400 ft. span could be built, costing for the bridge, with land damages and approaches, $15,000,000. At 179th St. the topography is exceptionally favorable, and here a 1,400-ft. cantilever could be built at a total cost of $10,000,000. The figures of cost are therefore in the ratio 3 : 1½ : 1 for the three sites studied.

THE CAUSE OF THE MARIANNA MINE DISASTER, which was noted in these columns Dec. 3, 1908, was found by a coroner's jury to be a blown-out shot which ignited gas and dust. An extract from the verdict follows:

> We, your jury, after hearing the evidence of mining experts, inspectors, miners and operators, find that the explosion in the Marianna mine, West Bethlehem Township, Washington Co., Pa., Saturday, Nov. 28, 1908, was due to a blown-out shot in Blanche entry No. 3, which ignited the gas and dust, and that a secondary explosion occurred in the main dip entries almost simultaneously. We further find that no blame is attachable for said accident.

The number of lives lost is now reported as 154. The evidence given before the jury brought out the fact that in Blanche entry No. 3 was found a shot hole 4½ ft. deep with about 10 ins. of the face of the hole blown off and containing charred paper which showed that the hole had been shot. In spite of strict rules against the use of black powder, a 5-lb. can of this explosive was found in the mine after the accident. Evidence was also found that coal dust had been used for tamping in a shot hole in No. 5 entry, although it had been explicitly ordered that only clay should be used. Whether the explosion which wrecked this "model mine" was due to the presence of dust, gas or some other explosive material, it seems to show that the utmost precautions in management can be rendered of no avail by the ignorance or recklessness of individual miners.

PORTLAND CEMENT PRODUCTION in the United States during 1908 is not expected to be greater than in 1907, according to a statement of Mr. E. C. Eckel, the cement expert, before the annual meeting of the Association of American Portland Cement Manufacturers in New York City, Dec. 8. This is in accordance with the prediction made by Mr. Eckel and others that the cement industry had reached a point when it would be affected by the general conditions of trade. Since 1896 the increase in production has been at a marvelous rate, regardless of the state of the market in other commodities and materials, but beginning in 1907 the curve of increase showed a marked decrease in rate. Thus, in rough figures, the production in 1904 was 26 millions of barrels; in 1905, 35 millions; in 1906, 46 millions, in 1907, 48 millions, which last figure will probably hold for the current year. As an illustration of the falling off of the curve, it is interesting to refer to an estimate made in these columns in Oct., 1907, which estimate, based entirely on the curve of the past ten years, and the number of new plants projected and reported, predicted a production of 80,000,000 barrels in 1908. It was stated, however, that this was only a paper estimate and that it was hardly possible that the high rate of increase could continue so that such a figure would be reached.

WATERWAYS AND PUBLIC DEBT.—"We are strongly inclined to the belief that there will be no necessity and no justification for incurring any national debt for purposes of public improvement in promoting the interests of commerce and industry in time of peace. The national credit and the strength it implies should be reserved for great national emergencies. The 'comprehensive plan' should be first worked out and some reasonable estimate of the time and cost of executing it should be possible before there is any talk of bond issues. No bonds should be authorized until it is demonstrated that they are necessary for some great public undertaking whose value to the country would justify the debt and which could not be otherwise carried out."—"Journal of Commerce," New York City.

We have, as the President says, been wofully improvident in dealing with our natural resources. It is best that we now take care not to be equally improvident with our national credit. The United States is the richest country in the world. It is the most lightly taxed of all the great powers. And in that fact lies not only our greatest national comfort but our strongest national de-

fense. It will be well if we do not permit ourselves to be carried away by the desire to do in a decade the work of a century and thereby involve ourselves in debt and resulting taxation. The digging of the Isthmian Canal and the systematic improvement of our waterways will, of course, tend to conserve and increase the national wealth, but they will not bring direct revenue to the treasury. On the contrary, they are likely to involve constant taxation for maintenance. If we enter upon this work on a large scale, it will be far better and safer to raise the money by some special tax levied for the purpose than to engage upon a debt-creating career whose end no man can foresee. We should pay off our national debt—not increase it. Let us pay as we go. "Posterity" will have its own troubles.—San Francisco "Chronicle."

STATISTICS OF ACCIDENTS TO WORKINGMEN in the United States are discussed in Bulletin No. 78 of the Bureau of Labor, Department of Commerce and Labor. It is stated that more than 30,000 workmen are killed in the course of a year in this country by accidents incident to their occupations. In connection with the present activity with regard to the reduction of fatalities in coal mines, it is of interest to compare the following average annual rates for the period 1897-1906:

Fatal Accidents per 1,000 Employees.	
Anthracite miners, Pennsylvania	3.18
Miscellaneous steel and iron workers, Pennsylvania,	4.30
Nut and bolt workers, Pennsylvania	5.40
Railway employees, United States	2.50

TWO NEW FOREST RESERVES were created by Presidential proclamation on Dec. 7. One is in Marion County, Florida, and will be known as the Ocala National Forest, and the other is in Billings County, North Dakota, and is to be called the Dakota National Forest. The former, of an area of 201,480 acres, is specially notable because it is the first national forest east of the Mississippi River.

PERSONALS.

Mr. D. G. Thomas has become Chief Engineer of the Denver Union Water Co., Denver, Colo.

Mr. W. H. Newman has resigned his position as President of the New York Central & Hudson River R. R.

Mr. R. K. Hamilton, of McKeesport, Pa., has become Superintendent of the mines of the Oak Grove Coal Co. at Sutterville, Pa.

Mr. Daniel S. Jones, Superintendent of Colorado Irrigation Division No. 3, with headquarters at Montrose, Col., has resigned.

Mr. William Kent, M. Am. Soc. M. E., will become General Manager of the Sandusky Foundry and Machine Co. at Sandusky, O., on Jan. 1.

Mr. J. S. Coffin has become Vice-President of the American Brake Shoe & Foundry Co. and has resigned his position as Vice-President of the Galena Signal Oil Co.

Mr. C. W. Bray, M. Am. Soc. M. E., President of the American Sheet & Tin Plate Co., has resigned. He will be succeeded by Mr. Eugene W. Pargny, now First Vice-President.

Mr. C. G. Delo, Division Engineer of the Chicago Great Western Ry., has resigned to enter the service of the Mexican Central Ry. as an engineer of maintenance-of-way.

Mr. Walter Fitch, M. Am. Inst. M. E., has resigned his position as Superintendent of the Calumet & Hecla Copper Mine in Michigan and will return to his former home in Salt Lake City.

Mr. H. W. Sheridan, Assistant Division Engineer of the Southern Pacific Ry. at Sacramento, Cal., has become Superintendent of the same division, succeeding Mr. Dennis Burkhalter, deceased.

Mr. William J. Davis, Superintendent of the Lake Erie & Western R. R. at Lafayette, Ind., has resigned to become General Manager of the Mississippi Valley Iron & Furnace Co., with headquarters in St. Louis, Mo.

Mr. John P. Ramsey, Vice-President of the Chicago, Peoria & St. Louis Ry., has been elected President. Mr. Ramsey has been virtually the chief executive since the retirement of Mr. Charles E. Kimball two years ago.

Mr. Harry W. De Graff, Assoc. M. Am. Soc. C. E., has been appointed Deputy State Engineer of New York. Mr. William B. Landreth, M. Am. Soc. C. E., has been appointed Special Deputy Engineer in charge of barge canal work.

Mr. Frank B. Cutstall, of Fort Wayne, Ind., has been appointed Superintendent of the electric railways of the Murdock syndicate which center in South Bend, Ind. He succeeds Mr. S. B. Mulholland, who has become Superintendent of the Murdock Gas Plant in Fort Wayne.

Mr. John J. Hannahan has become Superintendent of the American Automatic Stoker Co., with office at Chicago, Ill. He was formerly Grand Master of the Brotherhood of Locomotive Firemen and Engineers, but has severed his connection with that organization upon taking up his new position.

Mr. Charles M. Morse, M. Am. Soc. C. E., Engineer Commissioner of the Department of Public Works, Buffalo, N. Y., for the past seven years has resigned to enter private business. He will be succeeded by Mr. George H. Norton, who has been Assistant Engineer in the Bureau of Engineering for the last 20 years.

Maj. Jay J. Morrow, Corps of Engineers, M. Am. Soc. C. E., Engineer Commissioner of the District of Columbia, is to be transferred to other duties, and will be relieved by Maj. Spencer Cosby, Corps of Engineers, M. Am. Soc. C. E. It is reported that Maj. Morrow will be detailed to the position now held by Maj. Cosby, who is in charge of the District water supply.

Mr. John E. Pillsbury, Rear Admiral, U. S. Navy, has been retired on account of age. He was formerly in charge of the Equipment Department at Charlestown Navy Yard, and his last position was that of Chief of the Bureau of Navigation at Washington, D. C. In command of the U. S. Coast Survey Steamship, "Blake," he conducted extensive investigations of the Gulf Stream in 1884-91.

Obituary.

Elmer G. Eberhardt, Assoc. M. Am. Soc. M. E., Vice-President of the Newark Gear Cutting Co., died Nov. 21 at Newark, N. J. He was 27 years old and graduated in 1904 at Cornell University with the degree of M. E.

Thomas Musgrove Griffith, an old-time civil engineer, died at his home in West New Brighton, Staten Island, on Dec. 21. Mr. Griffith was 85 years old, and for nearly a score of years had been out of active professional work. He was educated at Hobart College, and was engaged in railway and bridge engineering during his years of active life. As a boy he was brought up in New York City, and he had many interesting reminiscences of the primitive days of New York. Nearly twenty years ago he told one of the editors of this journal of his recollection as a boy of driving his father's cow to the pasture and letting down the bars to turn her in on the site of the old Fifth Avenue Hotel, in Madison Square.

Thomas Gray, Vice-President of Rose Polytechnic Institute and Professor of Dynamic and Electrical Engineering in that institution, died Dec. 19 at Terre Haute, Ind. Dr. Gray was born in Lochgelly, Scotland, in 1850 and graduated in 1878 at Glasgow University. During the two years immediately following his graduation, he was an instructor in electrical engineering in the Imperial College of Engineering at Tokio, Japan. From 1881-8 he acted as an assistant to Lord Kelvin in electrical work, including that connected with the manufacture and laying of the Mackay-Bennett system of Transatlantic cables. He was the author of "Directions for Seismological Observations" in the "British Admiralty Manual of Scientific Enquiry," of the articles on telephones and telegraphs in the "Encyclopaedia Britannica," and of the "Smithsonian Physical Tables." He also wrote many papers on scientific and technical subjects and was engaged as an expert in electricity on the staff of the "Century Dictionary."

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 28-29. Annual meeting at Pittsburg, Pa. Secy., John C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 28-Jan. 2. Annual meeting at Baltimore, Md. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 11-16. Annual convention at Cleveland, Ohio. Secy., Geo. C. Wright, Harrison Bldg., Philadelphia, Pa.

IOWA ENGINEERING SOCIETY.
Jan. 13-14. Annual convention at Waterloo, Iowa. Secy., A. H. Ford, Iowa City, Iowa.

MICHIGAN ENGINEERING SOCIETY.
Jan. 12-15. Annual convention at Ann Arbor, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

INDIANA ENGINEERING SOCIETY.
Jan. 14-16. Annual convention at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 19. Annual meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

WOOD PRESERVERS' ASSOCIATION.
Jan. 19. Annual meeting at Chicago, Ill. Secy., C. W. Berry, Union Pacific R. R., Topeka, Kan.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20. Annual meeting at New York City. Secy., Charles W. Hunt, 220 West 57th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 26-28. Annual convention at Columbus, Ohio. Secy., Paul Hansen, Harrison Bldg., Columbus, Ohio.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 27-29. Annual meeting at Chicago, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28. Annual meeting at Toronto, Secy., C. H. McLeod, 413 Dorchester St., W., Montreal, P. Q.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 1-6. Annual convention at Rochester, N. Y. Secy., T. A. Randall, Indianapolis, Ind.

NATIONAL ASSOCIATION OF CEMENT USERS.—At the fifth annual convention in Cleveland, Ohio, Jan. 11-16, the following papers will be presented: "Use and Value of Cement Roads," J. H. Chubb, Chicago, Ill.; Report of Committee on Streets, Sidewalk and Floors (presenting proposed standard specifications for concrete roads), W. W. Schouler, Chairman, Newark, N. J.; "Comparative Cost of Reinforced Concrete Buildings," Emile G. Perrot, Philadelphia, Pa.; "Cost of Reinforced Concrete Construction as Applied to Bridges," H. [illegible] Quimby, Philadelphia, Pa., and E. P. Goodrich, New York City; "Decorative Concrete Stone," F. A. [illegible], Boston, Mass.; "Reinforced Concrete Residences," [illegible] Howes, Jr., New York City; "Monolithic Concrete [illegible] Buildings," Robert H. Aiken, Chicago, Ill.; "Advantages of Reinforced Concrete for Railway Construction," B. H. Davis, Hoboken, N. J.; "Cold Storage Warehouses of Reinforced Concrete Construction," J. P. H. [illegible], New York City; "Methods of Attaching Shafting and Machinery in Reinforced Concrete Buildings," W. [illegible] Bailey, Boston, Mass.; "Value and Cost of Steam Cured Concrete Blocks," F. S. Phipps, St. Joseph, Mo. More than 75 manufacturing companies have taken space for the exhibition of cement products and appliances.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the December meeting held at the Engineering Societies' Building, New York City, Dec. 21, Mr. W. S. Murray, Electrical Engineer of the New York, New Haven & Hartford R. R., presented "The Log of the New Haven Electrification." This paper described the faults of power-house, lines and locomotives as they had developed and had been corrected. Those who discussed the paper were largely of two classes. One of these, composed largely of designers of direct-current railway apparatus, could see no usefulness in the single-phase system and held that Mr. Murray's paper was evidence of this. The other class, and this included some interested in direct-current operation, acknowledged the advances that had been made in the development of the single-phase system for trunk line traffic. Dr. C. P. Steinmetz best expressed this view when he said that it was a fact that the single-phase system was actually carrying the traffic on the trunk line of a large railroad and that it bid fair to carry it all the more successfully as time progressed. He expected to see the alternating-current system prevail where heavy train units were to be handled at high speeds and infrequent intervals; with a direct-current terminal service where direct-current could be practically generated and distributed.

NEW ENGLAND WATER-WORKS ASSOCIATION.—At a meeting of the association held on the afternoon of Dec. 10, two papers were presented. The first, by Mr. Leonard Metcalf, M. Am. Soc. C. E., was on "Wrought-Iron Cement-Lined Water Pipe." This paper was some 70 printed pages in length, and was a valuable compilation drawn from the matter on the subject already in print, and of material specially collected by and for Mr. Metcalf, all for use by him as an expert witness in the recent appraisal of the property of the Portland Water Co. and other companies supplying Portland, Me., and vicinity.

In summarizing his final conclusions, Mr. Metcalf stated that experience in this country indicated wrought-iron cement-lined pipe was generally unsatisfactory for distributing mains and "much more satisfactory" for supply mains, qualifications being made by the author in each case. He also referred to the possibility that economical means will hereafter be developed for lining steel or even cast-iron pipe in a similar manner to that so successfully now employed in lining service pipes with cement, which will result in a better pipe than any yet used. But such use of cement is likely to be limited to furnishing a durable coating rather than water-tightness and added strength to the pipe.

Nearly all the discussion of Mr. Metcalf's paper was corroborative. One or two superintendents reported nothing but cement-lined pipe under their charge, and one stated that he had a small plant, with pressures from 70 to 100 lbs., in which the pipe was entirely satisfactory. Others could find nothing good to say for cement-lined pipe.

A paper by Mr. L. L. Tribus, M. Am. Soc. C. E., described in some detail an attempt to introduce in this country the quite common British system of compensation in kind for water rights taken in connection with surface water supplies. In discussing the paper, Mr. George A. King, Superintendent of the water-works at Taunton, Mass., cited a decision rendered only a few days ago in the case of the Town of Middleboro vs. Taunton, Mass. The town of Middleboro owns a water right from which water was diverted by the taking of the City of Taunton of water from Assawompsett Pond. Taunton raised the pond about 2 ft., storing surplus water, and although the quantity of water actually diverted figures about 2½ HP. taken away, it seemed, at least to the Taunton engineers, that Middleboro was actually gaining a benefit by the regulation, and the gaging showed that more water was flowing into the stream during the summer time since the change, than before. The jury (in the second jury trial) awarded over $13,000 damages, equivalent to about $7,500 at the time of taking, the remainder being interest. It is expected that the case will be appealed.

CONSTRUCTION NEWS

Supplement to ENGINEERING NEWS. New York, December 24, 1908.

CONTENTS.

CONSTRUCTION NEWS:
Plans and Specifications on File.....221
List of Contracts Pending.....221
Railways 221
Electric Railways 222
Light and Power Plants.....222
Bridges 222
Buildings 223
Water Supply and Irrigation.....223
Sewerage 224
Garbage Disposal 224
Streets and Roads 225
Manufacturing Plants 225
Miscellaneous Contracts 226
U. S. Possessions and Cuba.....226
Contract Prices 227
Engineering Material Prices 228
READERS' WANTS 226
INDUSTRIAL NOTES 227
TRADE PUBLICATIONS 228
PROPOSALS 228

CONSTRUCTION NEWS.

PLANS AND SPECIFICATIONS ON FILE.

(denotes that this work is advertised in Engineering News.)*

The following plans (P.) and Specifications (S.) are on file and may be seen at the office of The Engineering News Publishing Co., 220 Broadway, New York.

Bids close.	Work.	Place.	See issue.
12-24	*Seawall,	Fort Morgan, Ala. (P. & S.)	12- 3
12-28	Water meters,	Youngstown, Ohio (S.)	12-17
1- 4	Tank and tower,	Minerva, Ohio (S.)	12-17
1- 5	Bridge,	Fairport, N. Y. (S.)	12-17
1- 6	Garbage crematory,	Fort Slocum, N. Y. (P. & S.)	12-10
1- 9	Galleries, Wash.,	D. C. (Buildings) (S.)	12-17
1- 9	Storehouse, Key West, Fla. (S.)		12-24
1-15	*Dredging,	Mobile, Ala. (S.)	12-17

LIST OF CONTRACTS PENDING.

LIGHT, HEAT AND POWER PLANTS.

12-28 *Power plant, etc., Winnipeg, Man. 12- 3
12-28 Electric equipment, New York. 12-17
12-29 Light and power, New York. 12-17
1- 4 Lighting, Hartford, Conn. 11-12
1- 4 *Engines, generators, etc., Ft. Monroe, Va. 12-10
1- 5 Light fixtures, Frankfort, Ky. 12-17
1- 5 Light plant, Leesburg, Fla. 12-24
1- 6 Franchise, Highland Park, Va. 12-24

BRIDGES.

12-24 Bridge, Sumner, Wash. 11-26
12-29 Wing wall, Uniontown, Pa. 12-24
12-30 Bridge, Indianapolis, Ind. 12-24
1- 1 Rebuilding bridge, Newport, Ore. 12-10
1- 1 *Bridge, Handsboro, Miss. 12-17
1- 4 Bridge work, Sandusky, Ohio. 12-17
1- 5 Bridges, Stockton, Cal. 12-17
1- 5 Bridges, Albany, Mo. 12-24
1- 5 Bridge, Grenada, Miss. 12-17
1- 5 Bridge, Fairport, N. Y. 12-17
1- 6 Bridge, Granite Falls, Minn. 12-24
1- 8 Bridges, etc., Cincinnati, Ohio. 12-17
1- 9 Bridge, Sulphur, Okla. 12-24
1-11 Bridge repairs, Minneapolis, Minn. 12-17
1-11 Bridges, Newark, Ohio. 12-17
1-12 Bridges, Geneva, Neb. 12-17
1-12 *Bridge, Augusta, Ga. 12-17
1-12 Bridge, Rensselaer, Ind. 10-29
1-13 Bridges, York, Neb. 12-24
3- 4 Bridges, Paris, Ark. 12-17

BUILDINGS.

12-26 *Post-office, Americus, Ga. 11-19
12-26 School, San Jose, Cal. 12-10
12-28 Post-office, Lake Charles, La. 11-19
12-28 Schools, New York. 12-17
12-29 Post-office, Alton, Ill. 11-26
12-29 School, Philadelphia, Pa. 12-10
12-29 Warehouse, Baltimore, Md. 12-24
12-29 Repairs, etc., New York. 12-24
12-29 Building, Columbus, Ohio. 12-10
12-30 Building, Vernon, B. C. 12-10
12-31 Quarters, Ft. Howard, Md. 12-17
1- 2 Church, St. Paul, Minn. 12-17
1- 2 Court-house, Boston, Mass. 12-17
1- 2 Church, Evansville, Ind. 12- 3
1- 2 Church, Elkhart, Ind. 12- 3
1- 2 Automobile plant, Anderson, Ind. (Mfg. Pl.) 12-24
1- 4 School, Stamford, Conn. 12-24
1- 4 Post-office, Sault Ste. Marie, Mich. 11-26
1- 5 *Post-office, Niles, Mich. 11-26
1- 5 Plans, Pawhuska, Okla. 12-24
1- 6 Post-office, Paris, Ill. 12-10
1- 6 Quarters, etc., Ft. Slocum, N. Y. 12-10
1- 7 Post-office, Johnson City, Tenn. 12-10
1- 8 Dormitory, Stillwater, Okla. 12-17
1- 9 *Post-office, Murfreesboro, Tenn. 12-10
1- 9 Stone work, Washington, D. C. 12-24
1- 9 Storehouse, Key West, Fla. 12-24
1- 9 Galleries, Wash., D. C. 12-17
1-11 Post-office, Gainesville, Fla. 12-10
1-12 *Post-office, Warren, Ohio. 12-17
1-14 Plans, Milwaukee, Wis. 12- 3
1-15 Asylum, St. Louis, Mo. 12-10
1-18 *Hay-shed, Ft. Meade, S. Dak. 12-17
1-20 School, Wilkinsburg, Pa. 12-24
1-23 Quarters, etc., Portland, Me. 12-24
1-23 Post-office, Anderson, S. C. 12-24
1-26 Post-office, Logan, Utah. 12-24
2- 1 *Post-office, Fayetteville, Ark. 12-24
2-10 *Quarters, New London, Conn. 12- 3

WATER-WORKS.

12-28 Water meters, Youngstown, Ohio. 12-17
12-28 Pumping plant, Cuba (U.S. Poss.) 12-17
12-28 Water-works, Markdale, Ont. 12-24
12-29 Water pipes, Chicago, Ill. 12-24
12-29 *Water supply, Manhasset, N. Y. 12-24
12-30 Water mains, etc., New York. 12-24
1- 2 Fire hydrants, Louisville, Ky. 12-17
1- 4 Tank and tower, Minerva, Ohio. 12-17
1- 4 Pump, etc., Los Angeles, Cal. 12-24
1- 7 *Pressure tunnel, New York. 12-24
1-12 Water-works, Connersville, Ind. 12- 3
1-15 *Cement, Portland, Ore. 11-26
2-22 *Pump, Winnipeg, Man. 12- 3

SEWERS.

12-27 Sewer, Fort Wayne, Ind. 12-10
12-28 Sewer, Pipestone, Minn. 12- 3
12-28 Sewer, Youngstown, Ohio. 12-24
12-28 Sewer work, Houston, Tex. 12-24
12-28 Sewer, Kankakee, Ill. 12-24
12-28 Plans, West Allis, Wis. 12-24
12-29 Sewers, Canton, Ohio. 12-24
12-30 Sewer, Toledo, Ohio. 12-24
12-30 Sewers, Long Island City, N. Y. 12-24
12-30 *Sewers, Louisville, Ky. 12-10
1- 7 Sewer, Erie, Pa. 12-24
1-13 Sewage disposal plant, Polk, Pa. 12-17
1-14 *Sewer system, etc., Danville, Pa. 12-17

STREETS AND ROADS.

12-24 Sewers, New York. 12-17
12-28 Road, Noblesville, Ind. 12-10
12-28 Roads, Anderson, Ind. 11-26
12-28 Paving, etc., Philadelphia, Pa. 12-24
12-29 Road, Salisbury, Md. 12-24
12-29 Street impvt., Canton, Ohio. 12-17
12-30 Regulating, etc., Brooklyn, N. Y. 12-17
12-30 Paving, Hobart, Okla. 12-24
12-30 Paving, Columbus, Ohio. 12-24
12-30 Repairing, Long Island City, N. Y. 12-24
12-30 Regulating, etc., New York. 12-24
12-31 Road, Delphi, Ind. 12-24
12-31 Road, Kokomo, Ind. 12-17
1- 1 *Grading, etc., Humboldt, Tenn. 12-17
1- 2 Sidewalk, Griffith, Ind. 12-10
1- 4 Road, Crawfordsville, Ind. 12-17
1- 4 Roads, Greenfield, Ind. 12-17
1- 4 Roads, Tipton, Ind. 12-17
1- 4 Roads, Hartford City, Ind. 12-24
1- 4 Road, Williamsport, Ind. 12-24
1- 4 Roads, Danville, Ind. 12-24
1- 4 Road, Terre Haute, Ind. 12-24
1- 4 Road, Columbus, Ind. 12-24
1- 4 Road, Rushville, Ind. 12-24
1- 5 Road, Covington, Ind. 12-24
1- 5 Road, Wabash, Ind. 12-17
1- 6 Road, Madison, Ind. 12-17
1- 7 Roads, Peru, Ind. 12-24
1-12 Road impvt., Rockville, Md. 12-24
1-18 *Sidewalks, Pensacola, Fla. 12-24
2- 1 Paving, Appleton, Wis. 12-24
2- 1 *Pavement, Olympia, Wash. 12-24

MISCELLANEOUS.

12-24 Cement, New York. 12-17
12-24 Oil, stone, New York. 12-17
12-24 *Seawall, Fort Morgan, Ala. 12- 3
12-29 Tile drain, Rockwell City, Iowa. 12-17
12-29 Ditch, Burlington, Iowa. 12-24
12-29 Cranes, brass, Wash., D. C. 12-24
12-30 Cement, brick, lumber, N. York. 12-24
12-30 R. R. tracks, Ohio. (Rys.) 12-24
12-30 Covers, grates, rubber hose, N. Y. 12-24
12-31 Garbage, Cairo, Ill. 12-24
12-31 *Powder hoists, Wash., D. C. 12- 3
1- 2 Ditch, St. Paul, Minn. 12-17
1- 4 Metal work, Mobile, Ala. 12-24
1- 4 *Garbage incinerator, Portsmouth, Va. 12-24
1- 6 Ditch, Houston, Tex. 12-17
1- 9 Ditch, Anoka, Minn. 12-10
1-12 Flanging machines, Wash., D. C. 12-24
1-12 Fencing, New York, N. Y. 12-24
1-15 Tile ditch, Jefferson, Iowa. 12-24
1-15 *Cement, Portland, Ore. 11-26
1-15 Cruiser, Ottawa, Ont. 12- 3
1-15 *Dredging, Mobile, Ala. 12-17
1-20 *Incineration plant, Boston, Mass. 12-24
1-23 *Dredging, Bridgeport, Conn. 12-24
2-13 Drydock, Hawaii. 12-17

CIVIL SERVICE.

12-29 Teacher, etc., Philippines. 12-17
1- 4 Assistant, Philippines. 12-10
1- 6 Hull Draftsman, Wash., D. C. 12- 3
1- 6 Inspector of Boilers, Wash., D. C. 12-10
1- 6 Asst. Engr., Wash., D. C. 12-10
1- 6 Draftsman, Wash., D. C. 12-10
1-13 Junior physicist, Washington, D. C. 12-17
1-13 Chemist, Dover, N. J. 12-17
1-13 Electrician's helper, Washington, D. C. 12-17
1-13 Metallographist, Watertown, Mass. 12-17

RAILWAYS.

ALBERTA CENTRAL.—Application will be made by this company for powers to extend its proposed line from the westerly terminus near Rocky Mountain House, Alta., to the Grand Trunk Pacific Ry., in or near the Yellowstone Pass; also its present terminus near the elbow of Battle River to Saskatoon, Sask., or Warman, and also from east of Red Deer, Alta., southerly and easterly to Moose Jaw. Smith & Johnston, Ottawa, Ont., are solicitors for the company. Noted on Dec. 10.

ALGOMA CENTRAL & HUDSON BAY.—Surveys have been made for an extension from the present end of track at Mile, 69.35 miles, at the Chippewa River, Ont., north to Michipicoten, mile 103.65. No construction work is under way at the present time, as the extension has not yet been definitely decided upon. C. N. Coburn is Ch. Engr., Sault Ste Marie, Ont.

ALLEGHENY & NORTHWESTERN.—This company has been chartered to build a line between Mars and Evans City, Pa., seven miles. Capital stock, $70,000. Directors: John G. McPherson, Pres.; David Dillinger, Wm. E. Heller, C. S. Jarvis and J. L. Killep, all of Philadelphia.

AMERICAN R. R.—A charter has been applied for in Georgia by this company to build a line about 60 miles long from Abbeville, Ga., via Hawkinsville and Grovania, to Winchester, Ga. Capital, from $100,000 to $1,000,000. Bonds to the amount of $15,000 may be issued. Line will run through Wilcox Puliaski, Houston and Macon Counties. Headquarters will be at Hawkinsville. The incorporators are M. H. Boyer, of Hawkinsville, Ga.; Geo. W. Bannerman, John E. Lang, S. N. Kriescher, David J. Gitto, John S. Duncan, E. Parry Bannerman and George W. Flood, of Nassau County, New York; and John R. Parry, of Connecticut.

CANADIAN NORTHERN.—Surveys are now being made for an extension of this line from Saskatoon, Sask., to Calgary, Alta. M. H. McLeod is Gen. Mgr., Winnipeg, Man.

This company, it is stated, has taken up the option held on the Duluth, Rainy River & Winnipeg Railway, extending 84 miles through the State of Minnesota, from Fort Frances to Virginia. From this point it is proposed to push it through to Duluth, a further distance of some 70 miles. From there the Canadian Northern, in time, will have connections with Chicago and to the south with St. Paul and Minneapolis. The only portion of the C. N. R. system at present in the United States is 43 miles of its main line to Winnipeg, which runs south of the Lake of the Woods, in Minnesota.

CANADIAN NORTHERN QUEBEC.—The Government has granted subsidy contracts, at $3,200 a mile, for the construction of railway lines; one from near Arundel, Que., to a point near the united townships of Preston, Que., and Hartwell about 30 miles, and another to connect its Montfort and Gatineau line with the main line, about 15 miles.

CHICAGO, BURLINGTON & QUINCY.—The Chicago & Southern Ry. has been acquired by the C., B. & Q. Co.

CHICAGO, MILWAUKEE & ST. PAUL.—The Wisconsin State Railroad Commission has approved an issue of $150,000,000 additional stock by the Chicago, Milwaukee & St. Paul R. R. Co. for the purpose of building Pacific Coast extension. Of the amount named $77,000,000 has already been spent.

COLORADO & SOUTHERN.—See Chicago, Burlington & Quincy R. R.

ENID, OCHILTREE & WESTERN.—We are officially informed that this company is making surveys for its proposed railway which is to run from Ochiltree to Dalhart, Tex., 110 miles. Capital is ready for construction and right-of-way is secured. Company is not yet ready to let contracts. Geo. M. Perry is Pres., Ochiltree; W. D. Garwood is Ch. Engr., Dalhart.

GLENRAY & RICHWOOD.—Company has been chartered to build a railroad from Alderson, in Monroe County, to Richwood, in Nicholas County, about 40 miles. Capital, $20,000. Headquarters at Glenray, W. Va. The incorporators are F. M. Arnold, Harry E. Rugh, A. G. Corbett, A. J. Davis and Harry F. Stratton. This proposed line would connect the Chesapeake & Ohio and the Baltimore & Ohio railroads.

GRAYS HARBOR & PUGET SOUND.—Bids are under consideration for building this railway, which will be about 75 miles in length. Surveys are under way between Aberdeen and Olympia, Wash. J. M. Clapp is Ch. Engr., Seattle; W. J. Patterson is Gen. Mgr., Aberdeen, Wash.

GREENVILLE & KNOXVILLE.—An extension may be built from Cleveland, S. C., north to River Falls, five miles. J. N. Johnston, Ch. Engr., Marietta, S. C.

GULF, TEXAS & WESTERN.—We are officially advised that company will be ready to let contracts within the next 30 or 60 days for 20 miles of railway. The line will run from Burrs Ferry to Seymour, Tex., and will be about 500 miles long. Roy C. Megargel is Pres., 5 Nassau St., New York; John T. Witt is Ch. Engr., Jacksboro, Tex. Capital is partly obtained. Right-of-way is secured and surveys are made. Noted on Nov. 19.

INDIANAPOLIS UNION RY.—We are officially advised that contracts will be let about Feb. 15 for about two miles of new belt line in connection with track elevation project, as noted fully on Dec. 3. A. A. Zion is Supt.; P. J. Landers is Engr., Maintenance-of-Way, Indianapolis.

INTERNATIONAL RAILWAY OF NEW BRUNSWICK.—A subsidy contract has been entered into with the Canadian Government, superseding the contract previously made for the construction of a railway line starting from the western end of the 20 miles already built from Campbellton, N. B., and running to a point on the St. John River, between Grand Falls and Edmundston. In the new agreement, the subsidy rate is raised from $3,200 a mile to $6,400 a mile. Noted on Oct. 22.

METO VALLEY.—This company, which was recently incorporated in Arkansas, has made plans to build a line from McCreanor, Ark., south about 16 miles. The work will include one bridge. Contracts for building the line are to be let by Jan. 15, 1909. C. P. Harnwell, of Little Rock, Ark. is an incorporator. Noted on Nov. 19.

OHIO.—Bids are asked by the Board of Public Service, Columbus, Ohio, until noon, Dec. 30, for laying and ballasting railroad tracks adjacent to the Scioto River, Contract No. 5, Improved Garbage Disposal. Henry Maetzel, Ch. Engr.

PENNSYLVANIA R. R.—The DELAWARE RIVER QUARRY & CONSTRUCTION CO., of Easton, Pa., has been awarded a contract to widen the roadbed in a number of places at and above Martin's Creek, Pa.

ROARING FORK.—Surveys have been made for an extension to extend from Roaring Fork, Va., to Big Black Mountain, five miles. C. J. Creveling is Gen. Mgr., at Blackwood, Va.

ST. LOUIS & ST. LIBORY.—David O. Thomas, Ch. Engr., Belleville, Ill., advises us that contract for building bridges and for grading first eleven miles of this railway has been let to McCANN BROS., Herrin, Ill. Nine miles are now graded. This line will extend from a point on east bank of Mississippi River, opposite St. Louis, Mo., to St. Libory, St. Clair County, Ill., 32 miles. Surveys are made, capital partly secured and right-of-way obtained for one-third of the distance. Edward L. Thomas is Pres., Belleville. This company was recently incorporated in Illinois.

SAN ANTONIO & RIO GRANDE.—Contract has been given to the HIDALGO CONSTRUCTION CO., Hidalgo, Tex., for building 25 miles of this line. The projected route is from Brownsville, Tex., north to San Antonio, Tex., a distance of 300 miles. S. A. Robertson is Ch. Engr., San Benito, Tex.

SOUTHERN PACIFIC.—It is announced that the total estimated cost of the Beaverton-Willsburg cut-off and changes in the Yamhill division will be $911,314. Of this sum $214,694 has been expended in the purchase of the right-of-way and for bridge materials and for the grading of the new lines. The total length of the cut-off will be about 10.17 miles, including the high bridge over the Willamette River at Oswego. The cut-off involves a change of 5.3 miles in the Yamhill division. W. Hood is Ch. Engr., San Francisco.

ELECTRIC RAILWAYS.

NEW YORK, N. Y.—It is announced that the New York Central & Hudson River R. R. Co. will start about Jan. 1 to electrify the two tracks of its Harlem division. This division takes in the stations at Bronxville, Tuckahoe, Scarsdale, Hartsdale to White Plains, and also touches Mount Vernon. At Mount Vernon and White Plains new stations costing $100,000 each, will be built.

PORT JERVIS, N. Y.—F. A. Sawyer, Canton, Pa., Pres. of the Port Jervis & Delaware Valley R. R. Co., informs us that construction contracts will be let in January. Company has been chartered to build from Port Jervis to Milford, Pa., eight miles. Capital is partly secured. Right-of-way is obtained and survey has been made. C. E. Webster, Port Jervis, is Ch. Engr. Capital stock, $200,000. Noted on Nov. 26, under Railways.

LEBANON, PA.—The Lebanon & Southern St. Ry. Co. has been organized. J. M. Shenk, of Lebanon, is Pres. The line is to run from Campbelltown to Schaefferstown and Klienfeltersville, Pa.

CONCORD, N. C.—Franchise has been granted to James W. Barry, of Boston, for a street railway in Concord, construction of which is to begin within two years and is to be completed in six months. The franchise of the Concord Street Railway Co., granted two years ago, is reported as being taken over by the new company.

JACKSONVILLE, FLA.—D. G. Zeigler, Ch. Engr. of the Suwanee River Elec. Power Co., Jacksonville, informs us that company intends to let construction contracts about Feb. 15. Surveys have been made and right-of-way and capital secured. The company plans to connect Jacksonville with Waycross, Valdosta, Tipton, Ga., and with Lake City, Live Oak and other points in Florida. The railway will be about 300 miles in length. Hydro-electric power will be developed. W. B. Owen is Pres., Jacksonville. As noted on Nov. 5, the "company has been organized with a capital stock of $3,000,000 for the purpose of operating a series of electric railways extending 75 miles in four directions therefrom, also for furnishing power for manufacturing purposes to many cities within the circle named. It is also the intention of the company to dam the Suwanee River, near White Springs, Fla., and erect a power station there."

LEBANON, OHIO.—The Miami Transit, Light & Power Co. plans to construct its line between Xenia and Lebanon, 25 miles, next year. M. D. Burke, Fourth National Bank Bldg., Cincinnati, Ohio, is Engr.

BROWNSTOWN, IND.—The Brownstown Water, Light & Traction Co. has been incorporated for the purpose of building and operating water and light plants and street and interurban railways. Headquarters, Indianapolis. Incorporators: H. Jackson, James B. Thompson and W. B. Holton. Noted last week.

WARSAW, IND.—The City Council has granted franchises to the Winona Interurban Ry. Co. and the Winona & Warsaw Interurban Ry. Co. to operate cars in the city of Warsaw. The two franchises previously granted to the Winona Interurban Railway and the Winona & Warsaw Interurban Railway had expired.

VINCENNES, IND.—The Vincennes, West Baden & Louisville Ry. Co., it is stated, plans to begin grading on its proposed standard gage line within 60 or 90 days. The

line will connect Vincennes, Petersburg and Jasper with Frechton, Monroe City, Algiers, Otwell and Ireland. It will be about 50 miles long. It is planned to operate both gasoline and electric cars. Amusement parks may be established and operated by the company at Vincennes, Petersburg and Jasper. Company probably will furnish power for lighting to all important points along the route. Headquarters, 116 North Seventh St., Vincennes, Ind. Capital stock, authorized, $1,500,000; issued, $30,000. Bonds, authorized, $1,500,000. Officers: Thomas H. Adams, Vincennes, Pres.; Anthony M. Yelton, Vincennes, Secy.; John O. Davis, Evansville, Ind., Treas.

GRAND RAPIDS, MICH.—The Grand Rapids, Hastings & Battle Creek Interurban Ry. Co., it is announced, will use the overhead trolley system on its proposed line which will connect Grand Rapids, Hastings and Battle Creek and will be about 53 miles in length. Right-of-way is practically secured. Power for the operation of the line will be furnished by the Commonwealth Co., Jackson, Mich., and the Grand Rapids & Muskegon Power Co. Headquarters, Houseman Bldg., Grand Rapids, Mich. D. C. Jackson and Wm. D. Jackson, Chicago, Ill., are Elec. Engrs.; J. J. McVean, Grand Rapids, is Ch. Engr.; A. C. Sekell, Grand Rapids, is local representative.

EAST ST. LOUIS, ILL.—We are officially advised that grading has been completed on its line by the East St. Louis, Caseyville & Eastern Ry. Co., which was recently incorporated to build from East St. Louis to Caseyville, Ill., six miles. Survey is completed and right-of-way is secured. F. B. Harding is Pres. and E. G. Helm is Ch. Engr., East St. Louis. No date has been set for letting contracts. Noted on Dec. 3.

TAYLORVILLE, ILL.—The Taylorville-Nokomis Traction Co. has been incorporated to construct an electric railway from Taylorville to Witt, Ill., via Nokomis. Headquarters, Taylorville. Capital stock, $5,000. Incorporators: W. B. Adamé and A. R. Adams, Taylorville; P. M. Klinefelter, Morrisonville, Ill.; Alfred Griffin and W. F. Brockman, Nokomis, Ill. It will be about 25 miles long. Noted on Oct. 8.

FREEPORT, ILL.—The Freeport Interurban Ry. Co. has been incorporated in Illinois to construct an interurban electric railway from Freeport to South Freeport, thence to Polo, thence to Dixon. Capital stock, $2,500. Incorporators, Owen T. Smith, W. A. Hance, Edward Courtney, F. A. Read, N. Hettinger and A. Bidwell. Board of Directors: Owen T. Smith, W. A. Hance and A. Bidwell.

BOZEMAN, MONT.—The Gallatin Valley Elec. Ry. Co. will start construction about Feb. 1. Contracts for building this line will be let soon. It will extend from Bozeman to Ferris Hot Springs and Salesville, Mont., a distance of 18 miles. Power for the operation of the road will be rented from the Butte Electric & Power Co., Butte, Mont. Four motor cars will be placed in service when the line is completed. The repair shops will be erected at Bozeman. Capital stock authorized, $1,000,000; issued, $300,000. Officers: Ray M. Hart, Pres.; H. L. Casey, Secy.; George Cox, Treas., all of Bozeman. Noted on May 21 and April 2.

BROWNSVILLE, TEX.—Applications have been filed with the city clerk for street railway franchises. One application was filed by W. H. Mason, Jr., and L. H. Hallan and associates; and one by J. B. Scott and associates. In these applications it is agreed to give bonds in any sum required by the city, to begin actual construction within 60 days after the franchise is granted. The franchise is asked for 20 years.

PILOT ROCK, ORE.—Douglas Belts and A. R. Turner, of Pilot Rock, are interested in a plan to connect Pilot Rock, Nye, Albee, Ukiah, Umatilla, Hermiston, Echo and Pendleton by an electric railway.

BERKELEY, CAL.—Southern Pacific Co. has been granted franchise and permission to electrify its present lines, which will give the railroad five lines, extending from the southern to the northern boundaries of Berkeley. The railroad company has announced its intention of extending its present lines into Contra Costa County, so as to form a loop. W. B. Scott, Gen. Mgr. of the Western division of the Southern Pacific, announced that the road was ready to begin work immediately on transforming its system on the new lines. Estimated cost is $2,000,000. Previously noted.

VALLEJO, CAL.—Randall, Trowbridge & Co., of Oakland, Cal., have made application to the Vallejo Board of Trustees for a 50-year franchise in this city. R. L. Macfarlane is their local representative.

The Vallejo & Northern Elec. Ry. Co. plans to build its main line direct from Valejo to Sacramento; Suisun, Vacaville and Woodland will be reached by branches. The estimated cost is $6,500,000. T. C. Gregory is Pres.

LIGHT AND POWER PLANTS.

(denotes that this work is advertised in Engineering News.)*

NIAGARA FALLS, N. Y.—Arrangements are being made by the Niagara Falls Hydraulic Power & Mfg. Co. for the installation of an additional unit in its power-house. There are now eight 5,000-HP. units and one 10,000-HP. unit in operation at the plant. Arthur Schoellkopf, Niagara Falls, is Mgr.

NEW YORK, N. Y.—The Third Avenue R. R. Co. has contracted with the WESTINGHOUSE ELECTRIC & MFG. CO., of Pittsburg, Pa., to equip the sub-station being constructed at Webster and Brook Aves., the Bronx. The installation will include four 1,500-KW. rotaries and twelve 550-KW. air blast transformers. F. W. Whitridge is Receiver.

WASHINGTON, D. C.—Bids were received as follows on Dec. 17 at the office of the Superintendent of Construction of the new National Museum, Washington, D. C., for a generator switchboard: Walker Electric Co., Philadelphia, $9,475; General Electric Co., Schenectady, N. Y., $10,900; McCay Engineering Co., Baltimore, $12,427; Lord Electric Co., New York, $10,946; J. F. Buchanan & Co., Philadelphia, $10,800; Westinghouse Electric & Mfg. Co., Pittsburg, $9,925; A. & J. M. Anderson Mfg. Co., Boston, $10,582. Also for a quantity of heavy pipe, fittings and valves: Walworth Mfg. Co., Boston, $8,293; Wallace Stebbins & Sons, Baltimore, $8,210; M. W. Kellogg Co., Jersey City, $7,916, $8,142, $7,525; Bridgman Bros. Co., Philadelphia, $6,573; S. Faith & Co., Philadelphia, $6,009; Crane Co., Chicago, $7,166, $7,292.

HIGHLAND PARK (Richmond post-office), VA.—City will grant a 10-year franchise for construction of electric light and power system; bids to be opened Jan. 6. W. P. Redd, 1114 East Main St., Richmond, is Mayor.

BELINGTON, W. VA.—The Consumers' Heat, Light, Water & Power Co. has increased its capital stock from $80,000 to $135,000 and will undertake improvements, including extension of lines and new system of generating electricity. Charles Brandenburg, Belington, is Supt.

ATLANTA, GA.—The Piedmont Power Co. has been incorporated with $3,000,000 capital stock and privilege of increasing to $10,000,000, to develop water power on the Tugalo River, estimated to furnish 20,000 HP. W. L. Peel, F. J. Paxon, William M. Nixon, Davis Woodward, Sam D. Jones and others are incorporators.

HAWKINSVILLE, GA.—C. W. Harris, City Clerk, advises us that the city has voted on $15,000 of bonds for the purpose of installing an electric light and power plant. The bonds have not had time for validation and work will not begin until this is done.

WHITE SPRINGS, FLA.—Bids for the construction of the proposed power plant on the Suwanee River, near White Oaks, Fla., by the Suwanee River Railroad & Power Co. will be received about Feb. 10. The cost of the work is estimated at about $3,000,000. D. G. Ziegler & Co., of Jacksonville, Fla., will have charge of the work.

LEESBURG, FLA.—Bids are asked by the city until Jan. 5 for water-works and electric lighting plant. The city will give 5-year contract carrying with it 30-year franchise. L. M. Johnson is Clerk.

SEMINARY, MISS.—It is stated that John W. Burge, of Mobile, Ala., and associates, have purchased Seminary Falls and plan to build a dam for developing 300 HP., to be transmitted by electricity. T. W. Nichol, of Mobile, is Consult. Engr., and has made survey and estimated the cost of dam. A paper mill will be established in connection.

FLINT, MICH.—The Detroit "Journal" states that 13 dams are to be constructed on the Au Sable River in the northern part of the state at a cost of $8,000,000, by the Eastern Michigan Power Co., which has been granted a 30-year franchise by the Common Council to furnish light and power. It is planned to make Flint the distributing point, and cities in Saginaw, Genesee, Bay, Tuscola, Shiawassee, Oakland and St. Clair counties will be supplied by the company. The new company is the outgrowth of the Flint Light & Power Co., whose 30-year franchise, granted in 1903, will be repealed by the new franchise. F. A. Beard is Supt. of the Flint Light & Power Co.

CARLYLE, ILL.—Plans are being considered for improvements to the municipal electric light plant, which will include the erection of a power-house, the installation of boilers and one direct-connected unit with a rating of 150 KW. The cost of the work is estimated at about $20,000. George Schilling is Supt.

VILLISCA, IOWA.—A franchise has been granted to F. P. Taylor to construct and operate an electric light and power plant in Villisca. The cost is estimated at from $12,000 to $15,000. The Villisca Electric Co. has secured a temporary injunction enjoining the city from granting a franchise to F. P. Taylor to construct an electric light plant, it is stated.

REDWOOD FALLS, MINN.—Plans are being considered by A. C. Burmeister, of Redwood Falls, Minn., for the construction of a hydro-electric plant, the equipment of which will include two 100-KW. generators and water-wheels. The cost of the plant, including the distributing system is estimated at between $20,000 and $30,000.

GREAT FALLS, MONT.—We are officially advised that plans are being completed by Charles T. Main, Engr., 45 Milk St., Boston, Mass., for the development of two powers near Great Falls. The upper development is to be made at the falls known as Coulter's, Crooked and Rainbow, situated about three miles down the river from Great Falls. At this point the head will be about 105 ft. A crib dam about 25 ft. high will be built with masonry head gate, and waste gate structures. A steel penstock 22 ft. in diameter and about 2,500 ft. long will extend from the intake to the power-house. The latter will be of masonry construction containing about 36,000 HP. of wheels and electrical apparatus. Estimate cost, $1,500,000. The lower development is about twelve miles below Great Falls. Here the fall is about the same as at the upper development. The dam will be of the same construction as at Rainbow Falls, the canal being 500 ft. long, and directly below this, the power-house. The equipment will be a duplication of that at the upper development. The engineering corps is engaged in making surveys and in the preparation of plans. The work on the cofferdam is already begun and it is expected to proceed with the work of development to completion as fast as possible. A portion of the power developed will be used at the Boston & Montana Smelter, at Great Falls, Mont. The balance will be transmitted to more distant places. Henry A. Herrick is Engr.-in-Charge. Noted on Nov. 26.

MINCO, OKLA.—Plans and specifications for a municipal electric light plant and water works system, to cost approximately $30,000, are being prepared by Burns & McDonnell, Engrs., of Kansas City, Mo.

EL RENO, OKLA.—The El Reno Gas & Light Co., H. H. Stephens, of El Reno, Gen. Mgr., will build a 25-ft. extension to its electric light building and install a 600-HP. engine, which will double capacity of plant. The electric line and gas mains will be extended five miles each. Cost of improvements about $40,000.

REDDING, CAL.—It is stated that a deed to 100,000 ins. of water in Fall River has been filed for record. Roderick McArthur, McArthur, Cal., has conveyed title to the Lava Bed Power Co. The water is to be used in connection with an electrical power project involving the expenditure of $1,000,000. The water is to be conveyed by a tunnel four miles long through a mountain and into Pit River near Peck's Bridge, where a powerful fall can be had. This tunnel project is entirely distinct from that promoted by H. V. Gates. That project involves digging a tunnel seven miles long through a mountain in the Big Bend of the Pit, 20 miles or more below the McArthur site. The Yates project is awaiting the decision of the Redding Land Office on the application for a patent on the tunnel site. This case will not be decided until spring. In the meantime men are at work digging the tunnel.

GLENDALE, CAL.—Plans are being considered for establishing a street lighting system in Glendale. L. C. Brand, a property owner in Glendale, has offered to furnish electricity for lamps if the city will build the distributing system and lease it to him for a term of years at a nominal rental, the city to be given an option to purchase the plant at the expiration of the lease. A committee has been appointed to confer with Mr. Brand and to secure a definite proposition from him.

SALT LAKE CITY, UTAH.—We are officially advised that Louis C. Kelsey, City Engr., has submitted an estimate to the City Council of the cost of constructing an electric power plant at the north end of the Big Cottonwood conduit to operate the electric pump being installed in connection with the sewerage system. The cost of a 150-KW. plant is estimated at $30,000; a 300-KW. plant could be installed for $5,000 more. The annual cost of operating the 150-KW. plant is placed at $9,000 and of the 300-KW. plant at $10,000. The project is under consideration by the City Council.

BRIDGEWATER, N. S.—The Micmac Electric Co., Ltd., capitalized at $300,000, is applying for a charter to develop water power on the Port Medway River, from which they will run a 12-mile transmission line to the Liepeigate mining district for the purpose of supplying the Micmac and other mines with power. It is planned to operate an electric road for passenger and freight service.

BRIDGES.

CAMBRIDGE, MASS.—Plans have been prepared for the construction of a reinforced-concrete bridge at Boylston St., Cambridge. Estimated cost, about $100,000. The Cambridge Art Society is interested.

ROCHESTER, N. Y.—Bids are asked by F. C. Stevens, Supt. Pub. Wks., Albany, until noon, Jan. 5, for the construction of a lift bridge over the Erie Canal at Allen St., Rochester. This is a readvertisement of the work, as all the bids received on Dec. 3 have been rejected. The work must be completed by June 1, 1909.

NEW YORK, N. Y.—The Municipal Art Commission have approved designs for approach spans, suspended spans and anchorages for the Manhattan bridge.

OLEAN, N. Y.—The Town Council on Dec. 16 awarded the contract for the construction of a bridge over the Alleghany River at Clark St., East Olean, to the CANTON BRIDGE CO., Canton, Ohio, at $7,356. E. E. Allen is City Engr.

CAZENOVIA, N. Y.—The bids received on Dec. 22 by F. C. Stevens, Supt. Pub. Wks., Albany, for constructing a plate girder bridge over the outlet of Cazenovia Lake at Mill St., Cazenovia, N. Y., were as follows: Montour Steel Co., Montour Falls, N. Y., $4,041; United Construction Co., Albany, N. Y., $4,065; W. J. Burns Co., Syracuse, N. Y., $4,680.

*FORT HUNTER, N. Y.—We are officially advised that bids were opened on Dec. 22 by the Highway Commissioners of the towns of Glen and Florida, Montgomery County, for the erection of a 2-span steel bridge across Schoharie Creek here, and two concrete abutments and one pier, each span to be 228 ft. 1 in. long. The contract was awarded to the TOLEDO-MASSILLON BRIDGE CO., Toledo, Ohio, at $20,190.

UNIONTOWN, PA.—Bids will be received until Dec. 29 by the County Commissioners, Uniontown, for constructing an additional wing wall and fill for Point Marion bridge, Springhill Township; bids to be for concrete and stone per cu. yd. and for fill per cu. yd. Charles L. Davidson is County Clk.

NORFOLK, VA.—The City Council is considering the appropriation of $9,000 for the construction of a bulkhead and bridge over Mahone's Lake canal. W. T. Brooke is City Engr.

LYNCHBURG, VA.—The Common Council has adopted resolutions instructing the Engineering Department to prepare plans for the construction of a viaduct over Southern Ry. tracks on Fifth Ave. H. L. Shaner is City Engr.

LEXINGTON, S. C.—The County Commissioners on Dec. 7 awarded the contract for the construction of the steel bridge over the Saluda River to the CAROLINA ENGINEERING CO., Burlington, N. C., at $18,500.

BIRMINGHAM, ALA.—The Commissioners of Jefferson and Shelby Counties are considering the construction of a bridge over the Cahaba River.

KNOXVILLE, TENN.—The Viaduct Committee has secured plans for the construction of a viaduct over the Louisville & Nashville R. R. tracks and Southern Ry. tracks at Asylum Ave.

HURON, OHIO.—The Commissioners of Erie County, Sandusky, have selected the Osborn Engineering Co., of Cleveland, Ohio, as consulting engineers in connection with the new bridge over the Huron River here. Preliminary surveys and estimates are now being made to determine the location.

GREENFIELD, IND.—The GREENFIELD BRIDGE & SEWERAGE CO. has secured the contract for constructing a bridge over the Larrabee River in Brandywine Township.

HOMESTEAD, IND.—The Cleveland, Cincinnati, Chicago & St. Louis Ry. Co. will probably construct a concrete arch bridge over the railroad tracks here, the structure to have seven spans, each 30 ft. long.

INDIANAPOLIS, IND.—Plans and specifications for the construction of a bridge over Fall Creek at Capitol Ave. have been submitted to the Board of County Comrs. Bids are asked until Dec. 30.

*GREEN BAY, WIS.—We are officially advised that GREILING BROS., Green Bay, were awarded the contract on Dec. 18 by the city for the construction of the Walnut St. bridge over Fox River, at $150,000. Other bidders were: Standard Construction Co., Chicago, Ill., $185,000; Chicago Bridge & Iron Co., Chicago, $165,000; Milwaukee Bridge Co., Milwaukee, Wis., $162,897 (not formal); Adolph Green, Green Bay, $169,000. W. Reed is City Engr.

CEDAR RAPIDS, IOWA.—The City Council has decided to construct a steel bridge over Indian Creek at 13th St. T. R. Warriner is City Engr.

COUNCIL BLUFFS, IOWA.—The construction of a viaduct over the tracks of the Chicago Great Western R. R., W. H. Chadbourn, Ch. Engr., St. Paul, Minn., at Woodbury Ave. is under consideration.

GRANITE FALLS, MINN.—Bids will be received until Jan. 6 by the Commissioners of Yellow Medicine and Lyon Counties at the office of S. O. Tjosvold, Audr. Yellow Medicine County, Granite Falls, for constructing a steel bridge, 50 ft. span, 16 ft. wide and 12 ft. high, in the Townships of Swede Prairie and Normandie, Yellow Medicine County, and Westerheim and Vallers Townships, Lyon County.

MOTLEY, MINN.—The County Commissioners have awarded the contract for the construction of a steel bridge over Long Prairie River, one mile south of here, to the HEWITT BRIDGE CO., 834 Lumber Exchange, Minneapolis, Minn., at $4,950.

YORK, NEB.—Bids are asked until noon, Jan. 13, by W. A. Miller, County Clk., for the construction of steel and wooden bridges to be built in York County in 1909.

ABERDEEN, S. DAK.—The County Commissioners will construct six steel bridges throughout the county in the spring. Bids will soon be asked for the work.

ST. LOUIS, MO.—Plans for the piers of the municipal free bridge have been approved by the Chief of Engineers, U. S. Army, Washington, D. C. The structure will be a double-deck bridge, 2,000 ft. long, with center-span stretch of 620 ft.; clearance of 65 ft. above high water being provided. Estimated cost, including approaches, about $3,500,000. A. J. O'Reilly is Pres. Bd. Pub. Improvements.

ALBANY, MO.—Bids will be received by W. A. Henton, County Surv., until Jan. 5, for the construction of six 24-ft. I-beam and eleven 30-ft. I-beam bridges on steel legs; also for one 70-ft span on tubes.

DALLAS, TEX.—The Commissioners of Dallas County adopted plans on Dec. 9 for remodeling or rebuilding five bridges in Dallas County across the Trinity River. John Witt, County Engr., has been instructed to submit plans to Capt. A. E. Waldron, to be forwarded to the Secretary of War, Washington, D. C. Estimated cost of repairing four bridges, Molloy, Wilmer, Miller's Ferry and Hutchins, $160,700, and cost of county's part of new bridge which it is proposed to build near Santa Fe Ry. crossing, about $25,000.

SULPHUR, OKLA.—Bids are asked until 2 p. m., Jan. 9, by A. R. Greene, Supt. Platt National Park, Sulphur, for the construction of a steel bridge over Rock Creek in the park. Plans and specifications may be examined at the Superintendent's office.

RALSTON, OKLA.—The Commissioners of Osage and Pawnee Counties have awarded the contract for constructing a 90-ft. steel bridge over the Arkansas River near here to the MISSOURI BRIDGE & IRON CO., Fullerton Bldg., St. Louis, Mo., at $13,000.

ANADARKO, OKLA.—The County Commissioners on Dec. 8 awarded contracts for the construction of the Carnegie, Apache and Cyril bridges to the ILLINOIS BRIDGE CO., Oklahoma City, Okla., at $6,680.

PUEBLO, COLO.—The PUEBLO BRIDGE CO., Pueblo, has been awarded the contract, at $5,475, by the county, for the construction of a reinforced-concrete bridge over the St. Charles River. Bids were opened on Dec. 3.

LAS ANIMAS, COLO.—The PUEBLO BRIDGE CO., secured the contract on Nov. 30 for the construction of a 200-ft. span bridge over the Purgatory River, near here.

DENVER, COLO.—The contract for the steel structural work on the 20th St. viaduct was awarded on Dec. 10 by H. S. Crocker, City Engr., to the MILWAUKEE BRIDGE CO., 34th St. and Auer Ave., Milwaukee, Wis., at $287,430.

PESHASTIN, WASH.—Bids are asked until Dec. 28 by the County Commissioners, Wenatchie, until Dec. 28, for constructing a steel bridge, 250 ft. span, across the Wenatchee River here. Bowerman & McCoy, Seattle, Wash., are Engrs.

SPOKANE, WASH.—Plans are being considered by the City Council for the construction of a bridge from Division St. to Sharp Ave., of steel, 2,760 ft long, 48 ft. roadway, concrete floor, etc. Estimated cost, $311,000.

SACRAMENTO, CAL.—CLARK & HENERY, of Stockton, Cal., were awarded the contract on Dec. 8 for constructing the Galt-New Hope bridge, a steel draw, at $8,740.

STRATHCONA, ALTA.—The City Engineer has been instructed by the City Council to prepare plans for the construction of a high level bridge over Mill Creek.

BUILDINGS.

(denotes that this work is advertised in Engineering News.)*

PORTLAND, ME.—Bids are asked by Capt. F. J. Morrow, Q. M., U. S. A., Portland, until 10 a. m., Jan. 23, for constructing, plumbing, heating, electric wiring, etc., of barracks, officers' quarters, non-commissioned officers' quarters, firemen's quarters, and a band-stand, at Forts Williams and McKinley, Me.

NORTHAMPTON, MASS.—The Trustees of Smith College, Northampton, have engaged Charles A. Rich, 35 Nassau St., to prepare plans for an auditorium to cost $150,000.

CHELSEA, MASS.—We are officially advised that the proposed Masonic Temple to be built here will be three stories high and 50 × 120 ft. Edward I. Wilson, 101 Tremont St., Boston, is Arch.

NEWPORT, R. I.—We are officially advised that the lowest bids submitted on Dec. 14 for construction of (a) barracks and (b) N. C. O. quarters at Fort Geble, were: (a) Michael A. McCormack, 4 Sherman St., Newport, $84,815; (b) James M. Gillies, 8 Gillies Court, Newport, $5,998.

STAMFORD, CONN.—Bids are asked by the Board of Education, until Jan. 4, for constructing a 3-story school, 36 × 90 ft. Boring & Tilton, 32 Broadway, New York, N. Y., are Archs.

HARTFORD, CONN.—The West Middle School District has authorized its Committee, William H. Corbin, Chn., to secure plans for an assembly hall for the West Middle school, and for a building for the Noah Webster school. The assembly hall will be 100 ft. long by 60 ft. wide with a steel roof. The estimated cost is about $30,000 for the assembly hall and $50,000 for the school building.

NEW YORK, N. Y.—Bids are asked by the Board of Water Supply,, 299 Broadway, until 11 a. m., Jan. 5, for Contract No. 40: The construction of three field office buildings, three horse sheds and one stable, in the Esopus division of the Catskill aqueduct, in the towns of Olive and Marbletown, Ulster County, N. Y. J. Waldo Smith is Ch. Engr.

Helmle & Huberty, Archs., 190 Montague St., Brooklyn, have prepared plans for an extension to wing at the westerly end of main hospital building at the Kings County Hospital for the Department of Public Charities. Robert W. Hebberd, Comr. Estimated cost, $150,000.

The same architects have prepared plans for the New Bedford Street Hospital for the Department of Public Charities. Cost, $250,000.

NEW YORK, N. Y.—Plans have been filed with the Buildings Superintendent for a 6-story elevator apartment house to be built for the Scheer-Ginsberg Realty Co. on 147th St., east of Broadway. It will be of brick, with limestone trimmings. It will have a frontage of 100 ft. and a depth of 85 ft., and will contain 30 suites of apartments. It is to cost $125,000. B. W. Levitan, 20 West 31st St., is Arch.

Plans have been filed for a 6-story elevator apartment structure to be built at the corner of Broadway and 163d St., for Henry Bulman, 21 Fort Washington Ave. It will cost $225,000 and will be of brick trimmed with limestone and terra cotta, with a frontage of 99.11 ft. and a depth of 115 ft. There will be 45 suites of apartments. Schwartz & Gross, 347 Fifth Ave., are Archs.

Plans have been filed for the 12-story cooperative apartment house to be built for a company of which Richard Watson Gilder is head, at 24 Gramercy Park. It is to be of fireproof construction, colonial in design, with a facade of brick with trimmings of limestone, and will have a frontage of 51 ft. and a depth of 81 ft., with an extension. It will contain 17 suites of apartments. The building is to cost $180,000, and was designed by Herbert Lucas, 5 East 42d St.

The 12-story building of the Fidelity & Casualty Co., on the south side of Cedar St., from Trinity Pl. to Temple St., is to be enlarged. The plans provide for a 19-story annex. The annex will front 51.6 ft. in Liberty St. and will have a depth of 54.2 ft. It will be of ornamental brick, with trimmings of terra cotta and adorned with tall pilasters flanking the center and extending from the ground to the roof. The addition is to cost $500,000. Eidlitz & McKenzie, 1123 Broadway, are Archs.

A 6-story apartment house is to be built on a plot at Morningside Ave. West and 122d St. It will be of brick, with limestone trimmings, in the Renaissance style, with a broad bowed facade corresponding to the curve of the avenue at this point. This front will measure 121.11 ft. and the depth of the building will be 72.5 ft. It is to be erected for the Axelrod Realty Co., and will contain 31 suites of apartments. It is to cost $150,000, according to the estimate of George F. Pelham, 503 Fifth Ave., is Arch.

NEW YORK, N. Y.—The following bids were received on Dec. 14 by C. B. J. Snyder, Supt. School Bldgs., Dept. of Education, for general excavation, etc., Contract 1 of Washington Irving High School, on the easterly side of Irving Pl., between 16th and 17th Sts., Boro. of Manhattan, per cu. yd., (a) earth, (b) rock, (c) fencing: Thomas Crimmins Contracting Co., 444 East 69th St., (a) $1.82, (b) $2.58, (c) $3.00; Joseph A. Boyce, 843 Southern Boulevard, Long Island City, (a) $1.51, (b) $4.51, (c) $1.11; Bradley Contracting Co., 172 Bowery, (a) $1.00, (b) $1.70, (c) $1.25; M. Larkin & Co., 519 East 16th St., (a) $1.29, (b) $4.00, (c) $1.88; Bernard McQuillian, 437 East 65th St., (a) $1.50, (b) $3.00, (c) $1.50; Charles H. Peckworth, 415 Houston St., (a) $1.32, (b) $3.17, (c) $1.45; Charles E. Fraser, (a) $2.38, (b) $4.70, (c) $1.20; Ganavan Bros., 518 West 56th St., (a) $1.85, (b) $3.81, (c) 88 cts.; Thomas Cockerill & Son, 147 Columbus Ave., (a) $1.50, (b) $4.00, (c) $1.50; George Hildebrand, 38 Park Row, (a) $2.00, (b) $3.00, (c) $2.00.

Following are the bids received on Dec. 15 by Robert W. Hebberd, Comr. Dept. Public Charities, for furnishing all labor and materials required to install new steel grillies to galleries of male prison, cell blocks A, B, C and D, temporary corrugated iron protection fence in prison yard and other sheet iron and ornamental wrought-iron work, etc., at the City Prison, Raymond St., Boro. of Brooklyn: William Horne Co., 17 West St., $13,200; N. E. Construction Co., 225 Fifth Ave., $28,961; Van Dorn Iron Works, 1 Madison Ave., $18,423; Charles Meads & Co., 299 Broadway, $20,222; John T. Brady & Co., 155 Broadway, $16,840; A. Winternitz, 237 East 72d St., $22,900; George Hildbrand, 38 Park Row, $33,700; Lewis Wechsler, 1133 Broadway, $31,800.

The following bids were received on Dec. 17 by Robert W. Hebbert, Comr. Public Charities, for providing all labor and materials necessary or required for the excavation, masonry, steel and iron work, roofing and metal work, carpentry, electric work, heating and ventilating work, plumbing work and all other work for the construction and entire completion of a tuberculosis infirmary for the Metropolitan Hospital District, Blackwell's Island, Boro. of Manhattan: Boysford & Dickerson, 1170 Broadway, $269,962; Thos. B. Leahy, 1 East 42d St., $289,321; Kelly & Kelley, Inc., 451 East 42d St., $297,836; Richard L. Walsh, 100 William St., $294,900; Thomas Cockerill & Son, 147 Columbus Ave., $290,000.

NEW YORK, N. Y.—Bids are asked until 2.30 p. m., Dec. 29, by Robert W. Hebberd, Comr., Dept. of Public Charities, foot of 26th St., for furnishing all the labor and material required for altering and repairing present kitchen building and old boiler house at the Metropolitan Hospital, Blackwell's Island.

Plans have been filed for a 6-story elevator apartment house to be built at 142 and 144 East 56th St. for Emeline F. Parsons and Rosalie C. Slack as owners. It is to be of brick with limestone trimmings, the design being a modern Renaissance of somewhat unusual pattern, the facade being finished above the central entrance with a row of tall pilasters extending from the second to the fifth stories, and carrying an ornamental cornice. The building is to cost $125,000. Lawlor & Haase, 69 Wall St., are Archs.

WHITE PLAINS, N. Y.—The bids received by the State Armory Commission on Dec. 16 for constructing a State Armory at White Plains, N. Y., were: Morris Kantrowitz, Albany, N. Y., $61,400; Feeney & Sheehan Building Co., Albany, N. Y., $70,525; Peter Keeler Building Co., Albany, N. Y., $66,650; Foote Bros., Mt. Morris, N. Y., $73,173; Rocco Briante, White Plains, N. Y., $89,993; Nial Bros. Construction Co., Troy, N. Y., $61,961; Isaac A. Hopper, 1170 Broadway, New York, $91,531; John O'Rourke, White Plains, N. Y., $82,500; Wilmarth Building Co., 1 Madison Ave., New York, $58,968. The above amounts were the figures submitted for doing the entire work. Other subdivisions of the bids, however, called for certain additions and omissions which, if adopted, will increase or decrease those figures. Decision has been reserved as to the award of the contract. F. B. Ware is State Arch., Albany.

BUFFALO, N. Y.—We are officially advised that plans are in preparation for the erection of a municipal hospital for the treatment of contagious diseases at a cost of $250,000. The Board of Aldermen, acting on the recommendation of the Mayor, has voted that a bill be introduced in the State Legislature enabling the city to issue bonds for this purpose to the amount named. Dr. Ernest Wende is interested.

GREEN LAWN (L. I.), N. Y.—Contracts have been let for the erection of a country home to cost about $80,000 for Charles A. Gould, on his estate, about a mile and a half from Greenlawn. John Russel Pope, 527 Fifth Ave., New York, has drawn the plans, and WALTERS & WOODHILL, of Flushing, have the contract for the construction. The house will be 160 ft. wide and 60 ft. deep. The center portion of the front will be four stories in height. The house will be ready the middle of next summer. The barns and outbuildings have been completed.

ROME, N. Y.—The Board of Education has engaged E. E. Joralemon, Arch., 228 Second St., Niagara Falls, N. Y., to draw plans and specifications for a school house, to cost $45,000. It is expected they will be ready by Jan. 1, so that the Board may advertise for bids and let the contract about Jan. 15. Dr. A. Gillette is Pres. of the Bd. and Prof. L. N. Crane, Supt.

PHILADELPHIA, PA.—Oliver Randolph Parry has been commissioned to plan an operation of 80 houses and several stores, which will be built by Wilkie Bros., 400 Winona St., on ground they have purchased from L. C. Zimmerman at 54th St. and City Line Ave. The houses will be designed in different styles, in keeping with the surrounding section, which is largely suburban. The total cost will be close to $400,000.

John Megraw, Land Title Bldg., will start work within the next few weeks on the erection of 203 houses. They will be situated in vicinity of 44th St. and Kingsessing Ave., and will involve a total expenditure of $527,800. All of the houses will be two stories high, with porches, and set back from the street, with terraced lawns in front. Each one will be finished with all modern improvements. The new houses will range in size from 15 × 65 ft. to 18 × 85 ft. They will be built on both sides of Kingsessing Ave. and Regent St., between 54th and 55th Sts., and on the west side of 54th St., between Kingsessing and Greenway Aves.

WILKINSBURG, PA.—Bids are asked by the Board of Education, J. M. Lindsay, Secy., about Jan. 20, for the erection of the 3-story high school building to cost $350,000.

JOHNSTOWN, PA.—W. R. Myton, Arch., Lincoln Bldg., Johnstown, is preparing plans for a 3-story bank building for the First National Bank. Cost, $75,000.

PITTSBURG, PA.—Contract has been let by Lloyd Bros., Archs., Lewis Block, to MORRISON BROS. CO., 459 South St., for a 3-story school building for the Beltzhoover Board of Education, John L. Waite, Pres. Cost, $100,000.

An addition will be made to the group of buildings at Woodlawn Road and Fifth Ave., belonging to the Pennsylvania College for Women. Plans have been accepted from Alden & Harlow, Archs., Farmers' Bank Bldg., by the Building Committee, J. B. Finley, W. N. Frew and Dr. Henry D. Lindsay, Pres. of the college. The structure will be a dormitory building.

MILFORD, DEL.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., has awarded to LYNCH BROS., Lippincott Bldg., Philadelphia, Pa., contract for the construction of a post-office building at Milford, Del. Time, Aug. 31, 1909.

BALTIMORE, MD.—Bids are asked until Dec. 29 by Baldwin & Pennington, Archs., Professional Bldg., Baltimore, for removing present buildings and constructing State Tobacco Warehouses at Conway, Charles and Light Sts. The building will be six stories high, and will front on Conway St. 317 ft. and on Charles and Light Sts. 84 ft. each.

Contract has been awarded to GLADFELTER & CHAMBERS for five 2½-story dwellings, to cost $46,855 for the Roland Park Co., on University Parkway, between Cedar and Roland Aves. Edward L. Palmer has completed the plans. The proposed houses will be 33 × 40 ft. They will be of brick, with stone and cement foundations. The tiling and marble work will be of the latest pattern. Hot water heating and electric lights will be installed. The work will begin at once.

MOUNT WEATHER (Washington, D. C., post-office), VA.—Bids were received on Dec. 21 at the office of the Chief of the Weather Bureau, Washington, D. C., for the construction of buildings at the observatory, Mount Weather, Va. The lowest bid received was that of Glaze & Bro., Winchester, Va., at $44,000.

WASHINGTON, D. C.—Bids are asked by Elliott Woods, Supt. U. S. Capitol Bldg. and Grounds, Washington, until noon, Jan. 9, for cut stone work for the addition to the U. S. court-house, Washington.

LYNCHBURG, VA.—The Common Council has adopted a resolution providing for a joint committee to securep lans and bids for the proposed city hall, to cost not more than $150,000. H. L. Shaner is City Engr.

ROANOKE, VA.—The First National Bank is having plans prepared by John Kevan Peebles, Law Bldg., Norfolk, Va., for a bank and office building to be 50 × 100 ft., seven stories high, of steel frame, brick and granite, fireproof construction, with electric elevators, heating plant. Estimated cost, $150,000, not including ground. J. T. Meadows is Vice-Pres.

ANDERSON, S. C.—Bids are asked by James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., until 3 p. m., Jan. 23, for the construction complete (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. post-office and court-house at Anderson.

KEY WEST, FLA.—Bids are asked until 11 a. m., Jan. 9, by R. C. Hollyday, Ch. of Bureau Yards and Docks, Navy Dept., Washington, D. C., for constructing a concrete and steel storehouse at the Naval Station, Key West. Specifications are on file at the office of Engineering News, New York.

COLUMBIA, TENN.—GEORGE MOORE & SON, of Knoxville, Tenn., have been awarded the contract by James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., to build the U. S. post-office building at Columbia, at $55,000.

RICHMOND, IND.—O. G. Murray announces that he will build a theater in the spring to cost $60,000. The site has been purchased.

ANDERSON, IND.—The School Board has ordered plans for the construction of a high school building. Estimated cost, $120,000.

CARLISLE, IND.—Trustees of Sullivan Township will, it is stated, ask for bids soon for the erection of a school house on the site of the Excelsior school house, recently destroyed by fire.

MUNCIE, IND.—Cuno Kibele, Arch., Johnson Bldg., has about completed plans for a 3-story city hall, 115 × 125 ft., for the City Hall Building Committee, Leonidos Guthrie, Mayor, the building will be constructed of Bedford stone, brick, concrete and granite and will cost $125,000.

INDIANAPOLIS, IND.—It is reported that R. D. CONNELL, of Delaven, Ill., has been awarded the contract to construct the 78-animal stable at Fort Benjamin Harrison.

The Commissioners of Marion County are preparing to ask for bids for the construction of a $250,000 pauper home. W. H. Robertson is Chn.

COLDWATER, MICH.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., on Dec. 22 received as follows bids for the construction of a post-office building at Coldwater, Mich.: Charles Hoertz & Sons, Grand Rapids, Mich., $44,848; Paschen Bros., Chicago, $40,000; Charles W. Gindele, Chicago, Ill., $42,500; Scheurmann Lumber Co., Ltd., Saginaw, Mich., $45,994; Everly & Wallace, Plymouth, Ind., $44,987; James de Vault & Son, Canton, Ohio, $38,744; Northern Construction Co., Milwaukee, Wis., $43,000; E. Burner & Co., South Bend, Ind., $39,259; Sherman & Milnes, Coldwater, Mich., $49,000. Time, Jan. 1, 1910.

CHICAGO, ILL.—Contract has been let by Marshall & Fox, Archs., First National Bank Bldg., to GEORGE A. FULLER CO., Marquette Bldg., for the Blackstone Hotel. Cost, $1,500,000.

C. E. White, Jr., 615 Lake St., Oak Park, is preparing plans for a 4-story bank building to be built at Chicago. Cost, $125,000.

SIGOURNEY, IOWA.—The plans of Wetherell & Gage, 300 Youngerman Block, Des Moines, have been accepted for a 3-story court-house for Keokuk County at Sigourney. Cost, $110,000.

MASON CITY, IOWA.—Letts, Spencer & Smith are having plans prepared for a 4-story warehouse and office building. It will be of brick and mill construction, with composition roof, etc. Cost, $50,000.

MINNEAPOLIS, MINN.—We are officially advised that plans are being prepared by L. A. Lamoreaux, Lumber Exchange, Minneapolis, for the construction of a 3-story pressed brick and cut stone men's club house to be built on the State University campus. E. B. Johnson, city, is Secy. of the Alumni Association. Cost, $50,000. Contracts probably will be let in March.

WICHITA, KAN.—E. L. Masgueray, Arch., Dispatch Bldg., St. Paul, Minn., advises us that he is preparing plans for a Roman Catholic Cathedral for the Diocese of Wichita. Cost, $125,000. The plans call for a building 166 × 110 ft., with a dome 131 ft. above the ground and of limestone construction. The building probably will be started in the spring and the cost will be $125,000. The plans are being considered by the Bishop.

NEWTON, KAN.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., has awarded to CARL A. NILSON, Kemper Bldg., Kansas City, Mo., contract for the construction of a post-office building at Newton, Kan., at $43,070. Time, Jan. 1, 1910.

RUGBY, N. DAK.—Buechner & Orth, Archs., Manhattan Bldg., St. Paul, Minn., are preparing plans for a court-house, sheriff's residence and jail. It will be built of pressed brick and cut stone, fireproof construction, two stories high, having steam heating and electric lighting. Cost, $90,000.

HURON, S. DAK.—Plans are being prepared by Buechner & Orth, Archs., Manhattan Bldg., St. Paul, Minn., for the construction of a pressed brick and cut stone Masonic Temple to be built here. G. S. Hutchinson, Huron, is Chn. Bldg. Comn. Cost, $50,000.

*FAYETTEVILLE, ARK.—Bids are asked by James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., until 3 p. m., Feb. 1, for the construction (complete) of the U. S. post-office at Fayetteville, Ark.

DALLAS, TEX.—The Dallas Terminal Railway & Union Depot Co. will erect union depot, including freight terminal, train sheds and trackage, expending between $1,500,000 and $2,250,000. W. C. Connor is Pres.; C. F. W. Felt, Galveston, Tex., is Chief Engr. of Gulf, Colorado & Santa Fe Ry. Co.

COLLEGE STATION, TEX.—The Trustees of the Agricultural and Mechanical College have awarded contract to J. S. HARRISON, Waco, Tex., at $55,000, for erection of the proposed Engineering building. It will be fireproof, brick, with inside walls of plaster on metal lath, reinforced-concrete floors, gravel-covered roof. Plans by F. E. Gieske, College Arch., College Station.

TEMPLE, TEX.—The Gulf, Colorado & Santa Fe Ry. Co., C. F. W. Felt, Ch. Engr., Galveston, Tex., has adopted general plans and expects to soon begin erection of a passenger station at Temple. It will be two stories, brick, 40 × 196 ft. Cost, $75,000.

OKLAHOMA CITY, OKLA.—Lee Huckins Hotel Co. has awarded contract to SELDENBRECK CONSTRUCTION CO., Fullerton Bldg., St. Louis, Mo., for the erection of a 10-story hotel and office building combined. Mauran, Russell & Garden, Chemical Bldg., St. Louis, Mo., are Archs. Cost, $300,000.

PAWHUSKA, OKLA.—The Commissioners of Osage County will receive plans and specifications until Jan. 5 for a court-house, to cost $100,000.

LAWTON, OKLA.—Plans are being prepared for finishing a 5-story hotel for the Midland Hotel Co., Lawton, by Layton & Smith, Archs., Oklahoma City. J. H. Block is interested.

CHICKASHA, OKLA.—Bids are asked by the Board of Education, J. S. Tatman, Secy., until Jan. 4, for the construction of a 3-story and basement brick and stone high school building, 85 × 130 ft. Cost, $60,000. J. H. Felt, Shukert Bldg., Kansas City, Mo., is Arch.

SEATTLE, WASH.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., received bids as follows on Dec. 21 for the construction of the Government buildings at the Alaska-Yukon-Pacific Exposition, at Seattle: Strehlof, Freese & Petersen, Seattle, $235,999; James Black Masonry & Construction Co., Wright Bldg., St. Louis, $385,000; Burrell Bridge & Construction Co., Oakland, Cal., $288,459; Westlake Construction Co., 717 Locust St., St. Louis, $369,000; E. J. Rounds & Co., Seattle, $319,440; H. Chase & Co., Seattle, Wash., $265,000.

PORTLAND, ORE.—It is stated that W. S. Osborn, Hoffman House, will begin the erection of a 4-story hotel at the corner of East Eighth and Peral Sts. soon. The building will be modeled after the Hotel Portland. It will be situated across the street from and facing the court-house. The cost will approximate $75,000.

SAN FRANCISCO, CAL.—We are officially advised that plans have been completed and bids are being received for a 6-story business building, 50 × 120 × 60 × 60 ft., for Goldberg, Bowen & Co., grocers, 1242 Van Ness Ave., to be erected on the site of the firm's old store before the fire. The building will cost $150,000. Myers & Ward are Archs.

VANCOUVER, B. C.—The City Council contemplates expending $187,000 for school, $26,000 for School Board offices and $70,000 for small-pox hospital.

LOGAN, UTAH.—Bids are asked by James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., until 3 p. m., Jan. 26, for construction (complete) of the U. S. post-office at Logan.

WATER SUPPLY—IRRIGATION.

(denotes that this work is advertised in Engineering News.)*

*SPRINGFIELD, MASS.—We are officially advised that the contract for the construction of the Borden Brook dam and reservoir contract No. 5, Little River Water Supply, has been awarded by the Board of Water

Commissioners to COLEMAN BROS., 15 Court Square, Boston, Mass., at $169,875. E. E. Lochridge is Ch. Engr. List of bidders noted on Dec. 10.

PITTSFIELD, MASS.—The Council on Dec. 11 passed an ordinance authorizing the city to issue $33,000 of water bonds and $10,000 bonds for sewer repairs.

*NEW YORK, N. Y.—Bids are asked by the Board of Water Supply until 11 a. m., Jan. 7, for contract 36 for the construction of the north half of the Wallkill Pressure Tunnel, a tunnel in rock crossing under the valley of the Wallkill River, with three shafts 350 to 480 ft. in depth, and a short stretch of pain concrete conduit, known as cut-and-cover aqueduct, and for contract 37, for the construction of the south half of the Wallkill Pressure Tunnel, with three shafts 350 to 400 ft. in depth, and a short stretch of plain concrete conduit, known as cut-and-cover aqueduct. The pressure tunnel will be circular, 14½ ft. inside diameter, and the aqueduct, 17 ft. high by 17½ ft. wide inside. The work is located in the towns of New Paltz and Gardiner, Ulster County. Bids or proposals are invited for each contract separately and for both contracts combined. Any bidder may make a bid for either contract or for the two contracts combined. All bids for this work were rejected on Dec. 19.

NEW YORK, N. Y.—Bids are asked by John H. O'Brien, Comr. Water Supply, Gas and Electricity, until 2 p. m., Dec. 30, for furnishing and delivering 6-in. inside screw valves and hydrant valve boxes and covers, and for furnishing, delivering and laying water mains in Amsterdam, Haven, Lexington and Seventh Aves., 96th, 132d, 138th, 140th, 141st, 155th, 171st, 180th and exterior streets, and in Broadway, Borough of Manhattan.

Bids were received as follows on Dec. 17, by John H. O'Brien, Comr. Water Supply, Gas and Electricity, for furnishing and delivering c.-i. pipe, branch pipe and special castings for high-pressure fire service: Poyce Root Co., 20 Broad St., New York, $27,280; F. W. Drurry, 2 Rector St., New York, $28,-613.

*MANHASSET, N. Y.—Bids are asked by the Town Board of North Hempstead, Town Hall, Manhasset, until 2 p. m., Dec. 29, for furnishing a water supply for fire, sanitary and other public purposes in the Lakeville Water Supply district, North Hempstead. Monroe S. Wood is Town Clk.

SCRANTON, PA.—The Scranton Gas & Water Co. has awarded to the NEW YORK CONTINENTAL JEWELL FILTRATION Co., 15 Broad St., New York, N. Y., the contract for a filter for the North Scranton water supply at about $60,000.

ELM GROVE, W. VA.—J. A. Birkett and A. S. Bell have organized a company with $50,000 capital stock to furnish water, and will begin the construction of a reservoir about Jan. 1. After the completion of this work it is proposed to lay a 6-in. main to Elm Grove and other points.

TALAPOOSA, GA.—See item under Sewerage.

ATLANTA, GA.—The Fulton Prperties Co. has been incorporated with $100,000 capital stock by F. L. Eyles, C. J. Smith and W. P. Bloodworth, to construct water-works, etc.

COVINGTON, GA.—See item under Sewerage.

EAST POINT, GA.—Bids will be received until Jan. 19 for the construction of water-works and an electric light plant. Estimated cost, about $85,000.

LEESBURG, FLA.—See item under Light and Power Plants.

EUCLID, OHIO.—An ordinance authorizing a bond issue of $15,000 was passed by the Village Council on Dec. 14.

DETROIT, MICH.—All bids opened on Dec. 1 by the Board of Water Commissioners, Benjamin F. Guiney, Secy., for furnishing 10,696 tons of 42 and 48-in. c.-i. water pipe, 25 water gate valves, 16, 24, 30, 42 and 48-in.; 142 tons of large, special castings from 24 to 48-in., have been rejected. New bids will be received.

GRAFTON, ILL.—The contract was not let on Dec. 6 by the city for the construction of water-works, and the matter has been indefinitely postponed. H. C. Miller is City Clk.; Richard H. Phillips, Security Bldg., St. Louis, Mo., is Engr.

CHICAGO, ILL.—Bids are asked until 11 a. m., Dec. 29, by the city for furnishing and delivering to the city at the city pipe yards approximately 5,590 tons of c.-i. water pipe, 6, 8, and 12 ins. in diameter, according to plans and specifications on file in the office of the Department of Public Works, 803 City Hall. John J. Hanberg is Comr. Pub. Wks.

WAUKESHA, WIS.—The Board of Water Commissioners has recommended improvements, including the construction of a new reservoir and relaying 27,020 ft. of water mains. Estimated cost, $37,500.

SAINT EDWARD, NEB.—The citizens on Dec. 7 voted to issue bonds for the construction of water-works. Bids will be received about March 1. Estimated cost, about $20,-000. John W. Early, Columbus, Ind., is Engr.

*MURDO, S. DAK.—The contract for the construction of the pumping station, distribution system and steel tower and tank, bids opened on Dec. 6, has been awarded by the city to the DES MOINES BRIDGE & IRON CO., of Des Moines, Iowa, at $7,986. The Dakota Eng. Co., Mitchell, are Engrs.

RAPID CITY, S. DAK.—The lowest bid opened on Dec. 7 by Francis E. Leupp, Comr. U. S. Indian Service, Washington, D. C., for the construction of water-works at the Rapid City Indian School, was submitted by W. D. Lovell, of Minneapolis, Minn., at $15,508.

KAUFMAN, TEX.—The city has decided to extend the water mains and will install a turbine wheel.

ANSON, TEX.—The O'Neil Engineering Co., of Dallas, Tex., is preparing plans for the construction of water-works here. Estimated cost, about $20,000. The contract for construction will be let in about three or four months.

*GREENVILLE, TEX.—We are officially advised that bids were received by the city on Dec. 1 for furnishing c.-i. pipe, specials and valves. Contracts were awarded as follows: For c.-i. pipe, to AMERICAN CAST IRON PIPE & FOUNDRY CO., for 6, 8 and 16-in. pipe; valves, 6 and 8-in., to J. B. NEWHALL & CO.; valves, 14 and 16-in., to F. W. HEILMAN & CO.; hydrants and valve boxes, to DARLING PUMP & MFG. CO., Williamsport, Pa. J. W. Maxcy Co. are Engrs., Binz Bldg., Houston, Tex.

BROWNSVILLE, TEX.—A company has been formed here to construct an irrigation canal on the gravity plan, in the Rio Grande country. The canal will be 55 miles long, with various laterals. Estimated cost, $1,-000,000. A. Roberts is Ch. Engr.

ENID, OKLA.—The city has voted in favor of issuing $125,000 of water bonds.

HUGO, OKLA.—The city has accepted the preliminary plans and specifications prepared by Hiram Phillips, Consult. Engr., St. Louis, Mo., for the construction of water-works here. Plans and specifications in detail are now being completed. The contract for construction will be awarded about Jan. 15.

ASPEN, COLO.—C. E. Wilcox, on Dec. 1 awarded the contract for the construction of the Red Mountain ditch to C. A. SAVAGE at about $4,000. The ditch is being constructed by C. E. Wilcox and others of Woody Flats. The ditch when constructed will be about four miles in length, and the contract calls for its completion in May, 1909.

DENVER, COLO.—The Denver Reservoir Irrigation Co. awarded the contract on Dec. 11 to HARRINGTON & McNAB, of Fort Collins, Colo., for cutting a tunnel 1,200 ft. long through the mountain near Eldorado Springs, the tunnel to have a capacity of 1,100 ft. of water and cost $20,000.

The PHILLIPS & O'GARA CONSTRUCTION CO., of Denver, secured the contract for enlarging the canal, which runs from Eldorado Springs to Marshall Lake at about $100,000. W. S. Rosecrane is Consult. Engr.

SPOKANE, WASH.—The following are the bids received by the Board of Public Works for furnishing and delivering at city yards, 240 standard gate valves, all to stand a hydrostatic test of 300 lbs. per sq. in.: Crane Co., $4,813; McGowan Bros., $4,393; National Iron Works, $4,850; Union Iron Works, $4,-975. J. C. Ralston is City Engr.

PORTLAND, ORE.—The Water Board on Dec. 8 awarded contracts for 3,000 meters, 2,800 of which will be furnished by the HENRY R. WORTHINGTON CO., 118 Liberty St., New York, and the balance by the UNION METER MFG. CO. Total cost, about $20,000.

SAN FRANCISCO, CAL.—Judge Seawell on Dec. 12 signed an injunction against the Board of Public Works, restraining it from carrying on or concluding a contract with the Byron-Jackson Co. for the installation of turbine engines in the fireboats and projected pumping stations of the city. The contract was awarded, it is stated, on the advice of Percy V. Long, City Atty., who advised the Board that the lowest bid, that of the D'Olier Engineering Co., of Philadelphia, Pa., was irregular in some particulars. The Byron-Jackson Co. bid $120,000, and the bid of the D'Olier Engineering Co. was $7,000 less.

YUBA CITY, CAL.—The Board of Trustees has awarded the following contracts for furnishing material and installing the new water system as follows: MINNEAPOLIS STEEL & MACHINERY CO., Minneapolis, Minn., 91-ft. steel tower with a 28-ft. steel tank of 100,000 gallons capacity, $5,250; cement foundation for tower, $9 per cu. yd.; UNITED STATES PIPE CO., c.-i. pipe, 5,265 ft. 8-in. and 4,542 ft. 6-in., $32.28 per ton; 9,070 ft. 4-in., $33.28; 90, 4, 6 and 8-in. specials, 3¼ cts. per lb.; PACIFIC COAST SUPPLY CO., w.-i. pipe, per 100 ft., 2,145 ft. 3-in., $24.01; 500 ft. 2½-in., $18.35; 4,830 ft. 2-in., $11.49; 1,000 ft. 1-in., $5.28; 1,000 ft. ¾-in., $3.67; double gate valves, five 8-in., $16.95 each; five 6-in., $11.25; four 4-in., $6.95; 26 6-in. hydrants, $27.50 each; ten 2½-in. Globe valves, $4.80 each; 50 1-in. corporation cocks, $1.05 each; 50 ¾-in. service cocks, 78 cts each. Bids were opened on Dec. 8.

LOS ANGELES, CAL.—Bids will be received until Jan. 4 by the Board of Water Commisioners, John J. Fay, Jr., Pres., for the following: One horizontal 6-cylinder duplex double-acting condensing steam pump; one 65-HP. multi-cylinder distillate engine; a single-acting crosshead guided triplex power pump.

EMMETT, IDAHO.—The City Council on Dec. 4 opened bids for the construction of the water system here. The contract was awarded to J. H. FORBES & CO., Caldwell, Idaho, at $18,783.

LONDON, ONT.—The Water Commissioners have decided to take over the Kilworth water supply. Total cost of the project is estimated at $441,000.

MARKDALE, ONT.—Bids are asked until 6 p. m., Dec. 28, by the village for the construction of the several portions of the municipal water-works system. The work will include about 2,500 ft. of 8-in., 3,100 ft. of 6-in., 10,000 ft. of 4-in. and under, pipe, hauling and laying same, and furnishing and erecting either a stand-pipe or an elevated tank of about 50,000 gallons capacity. J. H. Stephenson is Reeve.

TORONTO, ONT.—C. H. Rust, City Engr., has been authorized by the Board of Control to purchase 281 water meters. Estimated cost, $10,996.

SEWERAGE.

(denotes that this work is advertised in Engineering News.)*

NIAGARA FALLS, N. Y.—Bonds for $70,-500 have been sold for the construction of the tunnel trunk sewer.

RICHMOND HILL (Jamaica, L. I., post-office), N. Y.—Plans are being prepared by the Sewer Department of the Boro. of Queens for the construction of the new sewer system here.

TROY, N. Y.—Bids for the construction of sewers in 24th St., North End, and in Glen Ave., from Winnie to Standard Aves., have been received by the Board of Contract and Supply as follows: Glen Ave.—Eveline Bros., Waterford, sewers, $1.59 per ft., laterals, 40 cts. per ft.; John Warnock & Son, sewer, $1.90 per ft., manholes, $40 each, laterals, 35 cts. per ft. 24th St.—Sewer, John Warnock & Son, $4 per ft., catch basins, $80 each, manholes, $54; William L. McDonough, sewer, $3.75 per ft., manholes, $85 each, catch basins, $125; Eveline Bros., Waterford, sewer, $4.49 per ft. for work complete. E. L. Grimes is City Engr.

BATAVIA, N. Y.—Plans are being prepared by Rudolph Hering, 170 Broadway, New York, for the construction of a sewerage system here. Myron H. Peck is Chn. Sewer Bd. Noted Dec. 3.

LONG ISLAND CITY (L. I.), N. Y.—Bids are asked until 11 a. m., Dec. 30, by Lawrence Gresser, Pres. Boro. of Queens, for constructing a sewer and appurtenances in Emma St., from William St. to Nurge St., and a temporary sewer and appurtenances in the same street from Nurge to Flushing Ave., Second Ward.

ERIE, PA.—Bids are asked until noon, Jan. 7, by B. E. Briggs, City Engr., for constructing a sewer here.

CHESTER, PA.—JOHN J. WILLIAMS & CO., of Chester, have secured the contract for constructing the Upland St. sewer, at $14,775.

HUNTINGDON, PA.—The Town Council has passed an ordinance providing for the issue of $10,000 of bonds for the improvement of the sewers here. J. B. Boring is Boro. Clk.

BALTIMORE, MD.—The Board of Awards opened bids on Dec. 16 for delivering 165,000 cu. yds. of crushed stone for the construction of the filter beds at the disposal plant on Back River and for the construction of additional storm water drains, the work to cost about $100,000. The bidders for the crushed stone were as follows: David Peoples, Betz Bldg., Philadelphia, Pa.; New York Continental Jewell Filtration Co., 15 Broad St., New York; Fisher & Carozza; Delaware River Quarry & Construction Co., and the Columbia Granite & Dredging Co. The bidders for the storm water drains were: The J. Connelly Construction Co.; J. Warren Reilly; David Peoples; T. J. O'Connell; Metropolitan Construction Co.; Ryan & Reilly; Booth & Flinn. The bids were referred to the Sewerage Commission for tabulation. J. Barry Mahool is Pres. Bd.

ROANOKE, VA.—The city has awarded the contract to the ROANOKE CONCRETE CO., of Roanoke, for the construction of two terra-cotta sanitary sewers at about $3,500. W. B. Bates is City Engr.

CHARLESTON, W. VA.—See item under Streets and Roads.

COVINGTON, GA.—The city has awarded the contract to the GENERAL CONTRACTING & CONSTRUCTION CO., Atlanta, Ga., for the construction of the sewer system and water-works. J. B. McCrary & Co., Empire Bldg., Atlanta, Ga., are Engrs.

TALLAPOOSA, GA.—The city is considering the construction of a sanitary sewer system and water-works. J. B. McCrary & Co., Engrs., Atlanta, Ga., will probably prepare plans and estimates for both systems.

*FITZGERALD, GA.—We are officially advised that the contract for the construction of a sewerage system, including about 20 miles of 6 to 18-in. vitrified pipe sewers, manholes, etc., bids opened on Dec. 15, has been awarded by the Water, Light & Bond Commission to SULLIVAN & LONG, Bessemer, Ala. J. C. Anderson is City Engr.

LOUISVILLE, KY.—The Commissioners of Sewerage on Dec. 11 awarded the contract to PAUL & KERSCHNER, Dayton, Ohio, for the construction of the 29th St. sewer, at $15,000. J. B. F. Breed is Ch. Engr.; Harrison B. Eddy, 14 Beacon St., Boston, Mass., is Consult. Engr.

SPRINGFIELD, OHIO.—M. J. Bahin, City Engr., has completed plans for the construction of sanitary sewers in Maiden Lane and Cedar St., 6,700 ft. Estimated cost, $22,000.

MOUNT VERNON, OHIO.—Plans have been approved by the State Board of Health for the construction of a sewage disposal plant for Mount Vernon.

YOUNGSTOWN, OHIO.—Bids are asked until noon, Dec. 28, by the Board of Public Service for the construction of a sewer in Canton St., from Belleview Ave. to South Ave. W. H. McMillin is Clk. Bd.

TOLEDO, OHIO.—Bids will be received until Dec. 30 by the Board of Public Service, Reynold Voit, Secy., for furnishing material and constructing a local sewer in several alleys and in a portion of Missouri St.

CANTON, OHIO.—Bids will be received until Dec. 29 by the Board of Public Service, C. A. Zellars, Clk., for constructing the Russell and Tyler St. sanitary sewer and Odd Row and Linden Ave. storm sewer, 5,933 lin. ft. of 8, 15, 18 and 24-in. pipes. J. A. Starrett is City Engr.

COLLEGE HILL (Cincinnati post-office), OHIO.—The State Board of Health has approved plans for a sewage disposal plant for College Hill.

ANGOLIA, IND.—The Town Board will ask for bids for the construction of a complete sewerage system as soon as plans are completed. Estimated cost, $85,000.

SOUTH BEND, IND.—The board of Public Works has ordered plans and will soon ask for bids for the construction of a sewer in Niles Ave., from Howard to Corby Sts. W. A. McIntyre is Chn.

INDIANAPOLIS, IND.—Plans for the construction of a sanitary sewer that will complete the system in Riverside Pl., south of 18th St. and east of the Belt Railroad tracks, have been completed by Blaine H. Miller, City Engr., and will be presented to the Board of Public Works for approval. The sewer will be located in the [illegible] valley north of Indiana Ave. and in other [illegible] between the Crawfordsville Road and [illegible] St. The size will range from an 8 to [illegible]-in. pipe. Estimated cost, about $9,000.

Plans are also being drawn [illegible] Charles A. Brown, Asst. City Engr., for [illegible] sanitary sewers in Harlan and Nelson Sts., but [illegible] will not be sent to the Board of Public Works until after Jan. 1.

GRAND RAPIDS, MICH.—Bids for the new sewage pumping station machinery, comprising electric motors and centrifugal pumps were opened by the Board of Public Works on Dec. 10 as follows: Buffalo Steam Pump Co., 490 Broadway, Buffalo, N. Y., $16,710 and $49,758; General Electric Co., Schenectady, N. Y., $15,182; Fort Wayne Electrical Works, $49,378 and $47,162; Westinghouse Electrical Mfg. Co., 209 Ninth St., Pittsburg, Pa., $15,924 and $61,022; Jeffersonville Iron Works, $38,370 and $44,170; Hunter Engineering Co., 121 South Eleventh St., Philadelphia, Pa., $45,843 and $69,200.

QUINCY, ILL.—The City Council on Dec. 7 passed the ordinance providing for the construction of the North End sanitary sewer. Bids will soon be asked. The Engineer's estimate for the work follows: 6,000 lin. ft. 24 × 36-in. egg-shaped brick sewer, consisting of two rings of brick, together with necessary construction, excavation and backfill, $4.50 per lin. ft.; 949 lin. ft. [illegible]-in. sewer pipe, with necessary construction, excavation and backfill, $2.68; 4,241 lin. ft. 24-in. sewer pipe, $2.05; 4,346 lin. ft. 18-in. sewer pipe, $1.56; 2,370 lin. ft. 12-in. sewer pipe, 70 cts.; 1,146 lin. ft. 6-in. standpipes for lateral junctions, 17 cts.; 122 6-in. quarter bends at 40 cts. each; 122 6-in. double T junctions at 65 cts. each; 77 manholes at $[illegible] each; 1 flush tank, $60; inspection, $720; water, $210; cost of making, assessing and collecting special tax therefor, $1,094. Total cost, $54,057. Fred L. Hancock is City Engr.

MOUNT MORRIS, ILL.—We are officially advised that J. A. Davison, Consult. Engr., Polo, Ind., has completed plans for the construction of sanitary sewers here, requiring 35,936 ft. of tile from 6 to 12-in., average cut about 8 ft.

KANKAKEE, ILL.—Bids are asked by the City Clerk until 2 p. m., Dec. 28, for the construction of a sanitary sewer here. Fred Mann is Mayor.

WEST ALLIS, WIS.—Bids are asked until Dec. 28 by the Board of Public Works, F. Phillips, Jr., Chn., for plans for septic tanks, filter beds or other disposal places for sewerage to complete the sewage system of the city, as adopted, plans of which system are now on file in the office of the City Clerk.

HERINGTON, KAN.—Bids will probably be received about Feb. 1 by B. C. Crary, City Clk., for the construction of sewers and a sewage disposal plant. Estimated cost, $50,000. Burns & McDonnell, Scarritt Bldg., Kansas City, Mo., are Engrs.

INDEPENDENCE, KAN.—We are officially advised that RUSHMORE & GOWDY, of Cherryvale, Kan., have been awarded the contract by the city for the construction of the west side sewer at $11,342. The work will include 860 ft. of 10-in., 3,744.5 ft. of 15-in., 3,620.5 ft. of 18-in. tile and 29 manholes. J. D. Cramer is City Engr.

CLARENDON, TEX.—The city has voted $25,000 of bonds for the construction of a sewer system.

HOUSTON, TEX.—Bids will be received until Dec. 28 by the city for the connection of South End sewer lift with sewer. H. B. Rice is Mayor.

BEAUMONT, TEX.—We are officially advised that bids received on Dec. 15 by the city for the construction of about 1,065 lin. ft. of 12-in. vitrified pipe sewer in a portion of Magnolia Ave., and 615 lin. ft. of 8-in. in Caldwell St. have been rejected. Work will be done by the city. J. G. Sutton is City Secy.

HOBART, OKLA.—The city has awarded the contract to T. C. BROOKS & SON, Jackson, Mich., for the extension of the sanitary sewer system to the Hill Addition, sewers to be of vitrified tiling, at $11,045. The work will require 1900 ft. of 12-in., 1,300 ft. of 10-in. and 13,080 ft. of 8-in. pipe, 31 manholes and six flush tanks. O. E. Noble is City Engr.

HOLDENVILLE, OKLA.—The city is having plans prepared for the construction of a sewerage system. Estimated cost, about $20,000.

SAN FRANCISCO, CAL.—The HANRAHAN-ERHARDT CO. has secured the contract, at $78,847, for constructing the north portion of the East Potero intercepting sewer.

GARBAGE DISPOSAL.

*BOSTON, MASS.—The time for submitting bids for the erection and operation on the property of the city at Fort Hill wharf, of a plant for the disposal by incineration of portions of the combustible waste, to be separated from city refuse, delivered at the plant, has been extended from Jan. 5 to noon, Jan. 20. Guy C. Emerson is Supt. of Streets. The approximate amounts of refuse to be treated, based on the collections for the present year, are as follows: Paper, 12,592 tons; mixed refuse (garbage, ashes and paper), 42,982 tons; mixed refuse (ashes and paper), 57,050 tons; dry-weather street-sweepings, 2,500 tons.

*PORTSMOUTH, VA.—Bids are asked by the Street Committee at the office of the City Clerk, until 8 p. m., Jan. 4, for furnishing all necessary materials and erecting complete an incinerator, or crematory, with a daily destructive capacity of 25 tons of wet and dry garbage.

CAIRO, ILL.—Bids are asked by the City Council until 5 p. m., Dec. 31, for the removal of all garbage of the city during the year 1909. Ernest Nordman is City Comptroller.

STREETS AND ROADS.

(denotes that this work is advertised in Engineering News.)*

HARTFORD, CONN.—Plans for the construction of state road work have been received in the office of the State Highway Commissioner, as follows: From W. H. Knight, Engr., 7,050 lin. ft. on the main road from Lakeville to Goshen; from A. B. Alderson, Engr., 13,031 lin. ft. in the town of Waterford and 26,220 lin. ft. in the town of Montville on the Norwich and New London Turnpike.

HARTFORD, CONN.—Contracts for the construction of state road work, bids for which were opened at the office of the State Highway Commissioner on Dec. 9, have been awarded as follows: Town of Waterford, 3,650 lin. ft. macadam and 2,100 lin. ft. of telford on the New London and East Lyme Turnpike, to HENRY H. MORGAN, New London, at $1.24 per lin. ft. for macadam and $1.84 per lin. ft. for telford, with native stone for bottom courses and trap rock for surfacing. Town of East Lyme, 9,850 lin. ft. macadam-telford road on the New London and Lyme Turnpike, including three 15-in., two 18-in. and one 24-in. tile culverts, to T. H. GILL CO., Winter Hill Station, Boston, Mass., at $1.67 per lin. ft. for macadam and $2.07 for telford with native stone for bottom courses and trap rock for surfacing.

The bids for 3,750 lin. ft. gravel road on Niantic and Lyme Turnpike were all rejected.

LONG ISLAND CITY (L. I.), N. Y.—Bids will be received until Dec. 30 by Lawrence Gresser, Pres. Boro. of Queens, for furnishing material and repaving with second-hand granite 7,475 sq. yds. on College Point Causeway, laying bluestone sidewalks on Potter, Eleventh and Twelfth Aves., 28,370 sq. ft.; and cement sidewalks on Jamaica Ave., 705 sq. ft.

NIAGARA FALLS, N. Y.—The H. P. Burgard Co., 275 Lathrop St., Buffalo, N. Y., submitted the lowest bid to the Board of Public Works on Dec. 15 for paving Fourth St. Twenty-nine bids were opened.

NEW YORK, N. Y.—Bids are asked until 2 p. m., Dec. 30, by John F. Ahearn, Pres. Boro. of Manhattan, for regulating, paving and repaving with granite block, sheet asphalt and asphalt block pavement on a concrete foundation the roadways of various streets; also for regulating, grading, curbing and flagging 167th St., from Audubon Ave. to Broadway.

*NEWTON, N. J.—We are officially advised that bids were received on Dec. 17 by the Board of Chosen Freeholders for grading and macadamizing a section of public road in the Township of Andover, the Borough of Andover and the Township of Byram, a distance of about ten miles. Loren C. Cole is Dir. Bd. The contract was awarded to GEORGE F. SNYDER, Drexel Bldg., Philadelphia, Pa., at $62,722.

PHILADELPHIA, PA.—Bids are asked by the Commissioners of Fairmount Park until 11 a. m., Dec. 28, for paving, cut granite curbing, vitrified blocks, cleaning wells, fencing, grouilithic and asphalt pavements for 1909. Jesse T. Vodges is Ch. Engr. and Supt.

SALISBURY, MD.—Bids are asked by H. M. Clark, County Road Engr., until Dec. 29, for 1¼ miles of shell-macadam road on the Jersey road.

SALISBURY, MD.—We are officially advised that all bids were rejected on Dec. 15 by the County Commissioners for improving the Athol road. The work will be done by the County under the supervision of H. M. Clark, County Road Engr.

ROCKVILLE, MD.—Bids are asked until noon, Jan. 12, by the County Commissioners of Montgomery County for improving the county highway between Bradley Lane and Kensington, known as the Kensington road. Robert G. Hilton is Clk. Comrs.

CHARLESTON, W. VA.—Bids will be received about Jan. 1 for about 110,400 sq. yds. of street paving; 47,580 lin. ft. of curb, and 7,340 lin. ft. of sewer, 8 to 42 ins. in diameter. W. A. Hogue is City Engr.

MIAMI, FLA.—The Dade County Commissioners are considering the construction of rock roads from Miami to Homestead, Fla., by finishing gaps in main line as now existing and also the extension of the main line of rock road from West Palm Beach to Stuart, Fla. Estimated cost, $1,500 and $2,500 per mile, respectively. Total cost, $150,000.

ST. PETERSBURG, FLA.—The EUREKA STONE & PAVING CO. have secured the contract from Snell & Hamlett for laying 12,000 sq. ft. of tile sidewalk on Lakeside sub-division. Work will commence at once. It is estimated that about 6,000 tile will be needed.

PENSACOLA, FLA.—The C. H. Turner Construction Co., Pensacola, is the only bidder at $3,426 for constructing a road on Palafox St., from De Soto to Jordan Sts., of Goulding cinders. L. E. Thornton is City Engr.

JACKSONVILLE, FLA.—The contract for delivering 5,000 cu. yds. of oyster shell paving material was awarded on Dec. 12 by the County Commissioners to H. P. HUTTO at $1.03 per cu. yd.

*PENSACOLA, FLA.—Bids are asked by the Board of Public Works until noon, Jan. 18, for the construction of concrete sidewalks, about 634,000 sq. ft. L. Earle Thornton is City Engr.

MOBILE, ALA.—Board of Public Works has instructed Wright Smith, Ch. Engr., to prepare plans for a municipal asphalt plant to care for asphalt-paved streets of the city.

MERIDIAN, MISS.—The Board of Supervisors of Lauderdale County have authorized the construction of a 5-mile road from Mount Hoary Church to Foster place.

LEXINGTON, KY.—The city has awarded the contract to CAREY & REED, of Lexington for paving South Ashland Ave. with asphalt. John Skain is Mayor.

COLUMBUS, OHIO.—Bids will be received until Dec. 30 by the Board of Public Service, E. W. Hirsch, Secy., for furnishing material and paving with hard-burned brick portions of Delaware and McAllister Aves. and Walnut St.

ELKHART, IND.—Bids will soon be asked by the Board of Public Works for paving West Franklin St. with trinidad asphalt. E. L. Arnold is Chn. Bd.

COVINGTON, IND.—Bids are asked by the Commisisoners of Fountain County until Jan. 5 for the construction of a gravel road in Wabash Township. W. B. Gray is County Audr.

RUSHVILLE, IND.—Bids are asked by the Commissioners of Rush County until 2 p. m., Jan. 4, for the construction of two miles of gravel road in Rushville and Anderson Townships. A. L. Winship is County Audr.

COLUMBUS, IND.—Bids will be received by the Commissioners of Bartholomew County until 10 a. m., Jan. 4, for the construction of 13,164 ft. of gravel road in Harrison Township. J. M. Davis is County Audr.

TERRE HAUTE, IND.—Bids are asked by the Commissioners of Vigo County until 11 a. m., Jan. 4, for the construction of a stone road in Honey Creek Township. N. G. Wallace is County Audr.

DELPHI, IND.—Bids are asked by the Commissioners of Carroll County until noon, Dec. 31, for the construction of a gravel road in Carrollton Township and a gravel road in Franklin Township. M. G. Haun is County Audr.

DANVILLE, IND.—Bids are asked by the Commissioners of Hendricks County until 10 a. m., Jan. 4, for the construction of two gravel roads 5,363.3 and 11,524 ft. in length, respectively. W. H. Nichols is County Audr.

WILLIAMSPORT, IND.—Bids will be received by the Commissioners of Warren County until 10 a. m., Jan. 4, for the construction of 10,685 ft. of gravel road in Pine Township. R. L. Winks is County Audr.

PERU, IND.—Bids are asked by the Commissioners of Miami County until noon, Jan. 7, for the construction of gravel roads Nos. 1 to 10 inclusive, one each in Erie and Peru Townships and eight in Clay Township. Charles Griswold is County Audr.

HARTFORD CITY, IND.—Bids will be received by the Commissioners of Blackford County until 2 p. m., Jan. 4, for the construction of 15,835 ft. of gravel road in Washington Township and 10,537 ft. of macadam road in Licking Township. L. W. Daugherty is County Audr.

CROWN POINT, IND.—The contract for constructing 10,453 ft. of macadamized road in Marion Township, bids opened on Dec. 8, has been awarded to AL. BORTZ, of St. John, Ind., at $5,732.

MICHIGAN CITY, IND.—The County Commissioners on Dec. 8 awarded the contract to JACOB ACKERMAN at $9,890 for the construction of the Frank Morrison macadam road. Clyde Martin is Engr.-in-Charge.

PEORIA, ILL.—The Board of Local Improvements has decided to pave Adams St. with creosoted wood block, 12,130 sq. yds. Estimated cost, $40,094.

An ordinance providing for resurfacing Knoxville Ave. with brick, 9,228 sq. yds., has passed the City Council. Estimated cost, $10,825.

APPLETON, WIS.—Bids are asked until 5 p. m., Feb. 1, by the Board of Public Works for paving a portion of Washington St. with creosoted wood block on a concrete foundation. E. L. Williams is City Clk.

LITTLE ROCK, ARK.—The City Council has adopted an ordinance appropriating $10,000 for repairing brick paving on Rock and Scott Sts., vitrified street-paving brick to be used. W. R. Duley is Mayor.

EL CAMPO, TEX.—The city has voted the issuance of $10,000 of bonds for street improvements, including laying sidewalks and drainage.

HOUSTON, TEX.—The city has awarded the contract to JOHN C. UNDERWOOD, of Houston, for paving San Jacinto, Preston and Dowling Sts. T. C. Tarver, Jr., is City Engr.

EL PASO, TEX.—The County Commissioners of El Paso County have voted $250,000 of bonds for road improvements.

HOLDENVILLE, OKLA.—The city will construct about five miles of concrete sidewalks in the residence section.

HOBART, OKLA.—Bids will be received until Dec. 30 by the city for about 47,500 sq. yds. of asphalt paving, with guttering and curbing. O. E. Noble is City Engr.

DENVER, COLO.—The DENVER & PUEBLO CONSTRUCTION CO., 67 Railroad Bldg., Denver, has been awarded the contracts for the curbing, grading and other improvement work in Capitol Hill Improvement districts Nos. 5 and 6. The company was the lowest bidder in No. 6 at $117,950 and in No. 5 at $88,043. The districts extend from Sixth Ave. to 14th Ave. and from Steele St. to Colorado Boulevard. The work will begin at once. J. B. Hunter is City Engr.

SPOKANE, WASH.—The following are the bids received by the Board of Public Works for street and sidewalk improvement: For grading, curbing and parking Cataldo Ave., from Howard St. to Washington St., engineer's estimate, $12,133, Foster & Hindle, $15,000; Abbott & Joslin, $12,990; Julia V. Costello, $11,632; John Fife, $11,544; Mitchell Bros., $11,087; H. L. LILIENTHAL, $10,340 (awarded contract). J. C. Ralston is City Engr.

*OLYMPIA, WASH.—Bids will be received by the city until 5 p. m., Feb. 1, for constructing about 6,000 sq. yds. of vitrified brick or creosoted wood block pavement, work to begin May 1, 1909. J. R. Dever is City Clk.

PORTLAND, ORE.—The PACIFIC BRIDGE CO. was awarded the contract on Dec. 11 by the Executive Board for bitulithic pavement on Belmont St., between East 40th and East 67th Sts., at $86,000.

SARNIA, ONT.—The following bids have been received by the Board of Public Works for paving Front St. with creosote block, the prices given being for 3-in. block and 4-in. block respectively: F. Gutteridge, $27,-100 and $32,262. U. S. block; A. Simpson, $29,252, U. S. block; Forst City Paving Co., London, $29,000 and $33,670, U. S. block, and for C. C. block made in Toronto, $25,445 and $26,857; General Contracting Co., Toronto, $26,110 and $26,925, C. C. block; R. Corrick & Sons, $27,686 and $33,390; Ontario Paving & Construction Co., Sarnia, $27,482 and $32,250; Concrete Steel Construction Co., Cleveland, $32,500 and $37,644.

MANUFACTURING PLANTS.

(denotes that this work is advertised in Engineering News.)*

LAWRENCE, MASS.—At a recent meeting of the stockholders of the Everett Mills, Lawrence, Mass., cotton manufacturers, it was voted to double the stock by issuing $700,000 in new stock. The company will increase its plant by erecting a building to employ 800 operatives. The mill, which will be five stories in height, with a basement, will be 826 ft. long, extending from the old storehouse at the corner of Canal and Union Sts. to Garden St. 463 ft. of it will be 100 ft. wide and the rest 75 ft. in width. It will be of brick. The contract for the construction has been let to L. E. LOCKE, of Lawrence, who is excavating for the concrete foundations. The concrete work will begin in the spring, and the building will be completed in Dec., 1909. Besides the office department the mill will be used for spinning, weaving and cloth finishing. It will increase the number of spindles 40,000, about 1,200 looms will be installed. Eight boilers will be installed in the power plant, which was erected in 1905. A Curtis turbine of 2,500-KW. will furnish power for the new mill.

PLYMOUTH, MASS.—Ground has been broken for an addition to the woolen mill of George Mabbett & Sons, on Water St., and construction is to be started at once. The new section is to be on the northern end of the main mill and will occupy the greater part of the open land extending toward Chilton St.

MALDEN, MASS.—Excavation has been started in Pearl St., adjoining the Edgeworth Station of the Western Division of the Boston & Maine R. R., as the first step in the construction of the new rubber factory to be erected there by the M. M. Converse Rubber Co., a new corporation with a paid-in capital of $250,000. The site consists of two acres of land fronting on Pearl St., and the building is to be 180 ft. long by 60 ft. wide, three stories high, fireproof and built of reinforced-concrete throughout. It will have a superstructure of concrete with brick trimming built over a steel skeleton frame. Contract for building the foundation was let to the HANSCOM CONSTRUCTION CO., and it is expected that the building will be finished March 1, 1909. M. M. Converse, of Medford, Pres. of the Beacon Falls Rubber Co. of Conn., is Pres. of the new company; Joseph F. Capen, of Stoughton, Treas., and Hugh Bullock, of Beacon Falls, Conn., is Supt. R. M. Saltonstall, of Newton, and Harry Dutton, of Medford, together with the other officers of the company, compose the Board of Directors. All kinds of rubber goods are to be manufactured in the new factory.

WATERBURY, CONN.—The Chase Rolling Mill Co. has prepared plans for an addition to its plant. A 1-story brick structure, 30 × 160 ft., will be erected.

BUFFALO, N. Y.—The Crosby Co., 171-189 Pratt St., has let contracts for additions to its metal stamping works on Pratt St. as follows for a brick 4-story factory, 40 × 146 ft., and for remodeling two 5-story malthouses, each 60 × 124 ft. (purchased from the American Malting Co.) into a 3-story factory building: Masonry to CHARLES BENICKS SONS CO., 1151 Main St.; carpentry to E. M. HAGER & SONS CO., 141 Elm St. R. J. Reidpath, 30 Builders' Exchange, is Arch.

We are officially advised that the Bergman Tool Co., 495 Ashland Ave., will erect a 3-story reinforced-concrete factory building, 42 × 170 ft., at Niagara St. and Forest Ave., at once. The contract will be let by S. Bergman, Pres., 102 Seneca St., at once. Estimates are being received. The building will cost $18,000; equipment, $15,000. C. D. Janson is Arch.

*FAIRPORT, N. Y.—The Sanitary Can Co. has prepared plans for the construction of a 3-story addition to its plant. The building will be of concrete or brick, 35 × 170 ft.

SYRACUSE, N. Y.—We are officially advised that the Syracuse Cold Storage Co., H. K. Chadwick, Pres., will build a cold storage plant at North West St. and the Erie Canal. There will be five buildings covering two acres. The main building will be eight stories in height, 84 × 85 ft., steel frame and brick construction, fireproof, with a 1-story power building of brick and steel construction. W. C. Jarvis, Consult Engr., 126 West 11th St., Indianapolis, Ind., is preparing plans and bids will be called by the owners about Jan. 1. The contract for the refrigerating machinery has been let to the DE LA VERNE MACHINE CO., foot of East 138th St., New York, N. Y.

The New Process Rawhide Co. will build a 2-story addition to its factory on Plum St. of brick and steel construction. Merrick & Randall, S. A. & K. Bldg., are preparing plans.

The Syracuse Auto-Cab Co., Harry L. Conde, Pres., is having plans prepared by Alfred Taylor, Arch., 53 Syracuse Savings Bank Bldg., for a 3-story fireproof garage and automobile agency building, 90 × 200 ft.

BINGHAMTON, N. Y.—The National Cigar Box Co., 301-303 Water St., is arranging to build an addition to its plant, having 11,000 sq. ft. of floor space and doubling its present capacity.

DANSVILLE, N. Y.—A. J. WERDEIN has been awarded contract to erect a brick paper mill at once for J. H. McNairn, of Toronto, Ont., to replace the plant destroyed by fire Dec. 16. Loss, $60,000. Work has been commenced.

ROCHESTER, N. Y.—The John Hofman Co., manufacturers of showcases, etc., have had plans prepared for a 1-story and basement brick and reinforced-concrete factory building, 381 × 110 ft., with wing 60 × 200 ft., and power-house, 30 × 60 ft., at Crouch and Leighton Sts., to cost $60,000. Charles S. Crandall and John F. Strobel, Jr., 404 Ellwanger & Barry Bldg., are Archs.

WEST MIDDLESEX, PA.—Pickands, Mather & Co., Western Reserve Bldg., Cleveland, Ohio, will erect a furnace at West Middlesex to take the place of the stack now being dismantled. About $300,000 will b expended. It is stated.

YORK, PA.—It has been announced that the York Mfg. Co. has purchased an additional tract and will expend $250,000 in enlarging its plant. A machine shop, three stories high, having a floor space of 50,000 sq. ft. or more, will be erected, and about $100,000 will be expended in modern equipment.

DUQUESNE, PA.—Ground will be broken soon for two finishing mills for the Duquesne works of the Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa., and in March construction of the experimental station of the U. S. Steel Corporation, at Duquesne, will be commenced. An expenditure of $2,000,000 will be necessary in carrying out these projects.

BALTIMORE, MD.—John Freund, Jr., Arch., 210 East Lexington St., advises us that bids have been received, but the contract is in abeyance for an addition to be built to the bakery plant of William Freihofer, at Howard and Stockholm Sts. The designs provide for a 2-story brick building fronting 40 ft., with a depth of 175 ft., of mill construction. Contract will be let early in the spring.

BENWOOD, W. VA.—The National Tube Co. has announced that it will at once begin the expenditure of $1,000,000 for a blast furnace at Benwood, W. Va. One of the mills of the company is at this point, and a semi-finished material has been carried from the mills at McKeesport to Benwood at a great expense, so it has been decided to build a blast furnace near the works in order to work the ore into pig iron where the iron is needed. The offices of the company are at the Frick Bldg., Pittsburg, Pa.

GREENSBORO, N. C.—We are officially advised that the management of the Revolution Cotton Mills at Greensboro intends to erect a bleachery and dye house at once to cost about $40,000. Two structures will be T-shaped, two stories high and 135 × 105 ft. and 60 × 45 ft. They will be built of brick, lumber and concrete, and will cost $20,000; equipment, $20,000. H. Sternberger is Secy.-Treas.

ATLANTA, GA.—Announcement has been made that the erection of a packing plant, with a capacity of approximately 4,000 hogs and 1,000 beeves a week, will be begun in Atlanta, April 1. The plant will be operated by the White Provision Co.

GADSDEN, ALA.—The Alabama Great Southern R. R. (Queen & Crescent Route), H. E. Warrington, Ch. Engr., Cincinnati, Ohio, will construct a 200-ft. extension to its main erecting shed. It is 800 ft. long at present.

BIRMINGHAM, ALA.—The Sloss-Sheffield Steel & Iron Co. will begin reconstruction of No. 3 furnace, which has been idle. The company intends to reline, build new stoves, etc., within four months. Cost, about $250,000.

EUFAULA, ALA.—Donald Comer, representing his father, Gov. B. B. Comer, of Montgomery, Ala., is in Eufaula, Ala., arranging to put in operation the Eufaula Cotton Mills, the control of which Gov. Comer purchased some weeks ago. It is reported that $50,000 will be expended for improvements. The management is arranging for the improvements to be made after Jan. 1. The plant has 12,500 ring spindles and 370 looms, producing sheetings.

KOSMOSDALE, KY.—We are officially advised that W. N. KRATZER & CO., 3212 Smallman St., Pittsburg, Pa., have been awarded the contract for the furnishing, fabricating, constructing and erecting structural steel work in rebuilding the Kosmos Portland Cement Co.'s plant, Kosmosdale, destroyed by fire. The plant consists of eight buildings and the connecting bridges.

FRANKLIN, KY.—The Franklin Electric & Ice Co., recently incorporated, awarded contract to T. J. CHRISTMAN & CO., of Nashville, Tenn., for erection of proposed plant, 60 × 90 ft., brick construction, with cement floors, metal roof, walls lined with cork. Cost, about $10,000. Machinery for 18-ton plant has been purchased from the HENRY VOGT MACHINE CO., Louisville, Ky. McDonald & Todd, Louisville, Ky., are Archs.

MASSILLON, OHIO.—We are officially advised that H. A. Croxton and C. A. Gates are interested in construction of a bridge and structural steel plant here. Plans for the buildings have been completed and construction will be started in the spring. C. S. Davis, Ohio Bldg., Toledo, Ohio, is Engr.

ANDERSON, IND.—Bids are asked until Jan. 2 for the construction of a plant for the Rider-Lewis Automobile Co. Subsequent bids will be received for power equipment.

GOSHEN, IND.—The Directors of the Auto Roller Bar Co. have decided to build and equip a factory here.

EVANSVILLE, IND.—E. K. Ashby & Co. have ordered plans for the erection of a brick building. Harris & Shopbell are Archs.

STEVENTS POINT, WIS.—We are officially advised that the Vetter Mfg. Co. has engaged C. F. Ringer & Co., 106 Mason St., Milwaukee, Mill Archs., to prepare plans and specifications for a wood-working factory building to cost $35,000. The structure will be three stories high, with basement, 73 × 200 ft. Bids will be received in January.

ST. LOUIS, MO.—According to the St. Louis "Times" workmen have begun removing the debris preparatory to rebuilding the main portion of the plant of the Lohse Pat-

ent Door Co., King's Highway and Missouri Pacific tracks, destroyed by fire recently, at a loss of $100,000.

The Allan-Pfeiffer Chemical Co. will erect a $100,000 factory, 200 × 187 ft., on Laclede Ave., west of Sarah St. Work on the factory will begin early in January. Plans and specifications have been drawn by A. F. Haeussler, Arch., 4415 Market St., and he will supervise the construction. The plans call for a brick and stone building three stories high and containing a floor area of about 3½ acres. The structure will be fireproof. Charles E. Lane is Pres.; J. M. Lynn, Secy.

WELLSVILLE, MO.—Eugene Green, representing a St. Louis glass company, proposes to establish a fire-brick plant in Wellsville to cost $50,000. The company has an option on about 2,000 acres containing deposits of fire clay.

BONHAM, TEX.—The management of the Bonham Cotton Mills, of Bonham, has decided upon improvements to be undertaken after Jan. 1. The directors have authorized the betterments, having appropriated $30,000 for the purchase of new machinery, etc. The company operates 12,000 ring spindles and 352 looms (100 being for narrow fabrics) on the production of sheetings, about 180 persons being employed. The improvements will include additions to spindles.

KINGSTON, ONT.—The factory occupied by Wormwith & Co., piano manufacturers, was destroyed by fire on Dec. 6. Loss, $110,000, partially covered by insurance.

WINNIPEG, MAN.—H. A. Mullins and associates here are planning erection of a packing plant to cost $225,000. Work probably will be started in the spring.

MISCELLANEOUS CONTRACTS.

U. S. RECLAMATION SERVICE.—Items regarding irrigation, canal projects, etc., will be found under Water Supply—Irrigation.

FREIGHT SUBWAY.—New York, N. Y.—See under Railways—"New York City."

WHARF.—St. John, N. B.—R. ROBERTS' SONS have been awarded contract for repairing the Wiggins Wharf, at $10,783.

*DREDGING.—Bridgeport, Conn.—Bids are asked until noon, Jan. 23, by Maj. Harry Taylor, Corps Engrs., U. S. A., New London, Conn., for dredging in Bridgeport Harbor.

SUBWAY.—Bisbee, Ariz.—The City Council has awarded contract to the EL PASO & SOUTHWESTERN RY. CO., at $53,500, to build a subway.

LEVEE.—New Orleans, La.—Contract for construction of the Golden Grove levee in St. James Parish has been awarded to R. T. CLARK, of Natchez, Miss., at 21.89 cts. per cu. yd. Estimated quantity, 25,000 cu. yds.

PIER.—Cleveland, Ohio.—The contract for constructing wharf at Cleveland Harbor has been awarded to the GREAT LAKES DREDGE & DOCK CO., Chamber of Commerce Bldg., Chicago, Ill., at $83,735.

*CEMENT.—Portland, Ore.—Bids are asked by the U. S. Reclamation Service, 417 Beck Bldg., Portland, until 10 a. m., Jan. 15, for furnishing 25,000 bbls. of Portland cement f. o. b. cars at the works of the bidder.

SIGNALS.—New York, N. Y.—The UNION SWITCH & SIGNAL CO., 143 Liberty St., New York, has been awarded contract for additional signaling and interlocking equipment for the Hudson Companies tunnels.

TILE DITCH.—Jefferson, Iowa.—Bids will be received until Jan. 15 by the Joint Board of Supervisors of Greene and Boone Counties for constructing a drain tile ditch. E. S. Gose, County Audr., Jefferson.

METAL WORK.—Mobile, Ala.—Bids are asked until noon, Jan. 4, by the Light-House Engineer, Mobile, for furnishing materials and labor of all kinds necessary for the construction and delivery of the metal work for Galveston Jetty Light Station, Tex.

SMELTER.—Carson City, Nev.—The Western Smelters Corporation will erect a large smelter at Merrimac, on the Carson River, five miles east of Carson City. J. W. Boileau, Yerington Bldg., Carson City, is Consult. Engr.

DITCH.—Taylorville, Ill.—E. A. Vandeveer, of Taylorville, and Benj. Knudson, of Springfield, have let contract to the N. C. McGINNIS CO., of Bement, Ill., for construction of a ditch 2¾ miles long. Estimated cost, $12,000.

*DREDGING.—Galveston, Tex. Bids were received by Capt. John C. Oakes, Corps Engrs., U. S. A., Galveston, for dredging in Buffalo Bayou, Tex., and contract has been awarded to the ATLANTIC GULF & PACIFIC CO., 13 Park Row, New York, at 13.45 cts. per cu. yd. Estimated cost, $100,000.

*TILE.—Cerro Gordo, Ill.—Bids were received on Dec. 4 for furnishing, hauling and laying about 13,000 ft. of tile from 5 to 24-in. Profiles in office of J. C. Locher, Town Clerk, Cerro Gordo, Ill. Contract was awarded to H. S. WALTER, Cisco, Ill., at $4,522. W. J. Day, Bement, Ill., Engr.

CULVERT.—East Cleveland, Ohio.—Bids are asked until Jan. 9 by Kline F. Leet, Village Clk., Room 326 Williamson Bldg., Cleveland, for furnishing material and constructing a 24-in. circular culvert, in certain parts of the village. Pease Engineering Co., 931 Williamson Bldg., Cleveland, are Engrs.

CONCRETE WORK.—Clarksdale, Miss.—The Hopson Bayou Drainage Commission awarded contract to SOUTHERN CONCRETE CO., Memphis, Tenn., for concrete work at mouth of drainage ditch. Concrete work will cost 30 cts. per cu. yd., and that reinforced by steel $12.15. Total cost, $4,300.

LEVEE.—New Orleans, La.—Bids were received on Dec. 17 by Capt. H. Burgess, Corps Engrs., U. S. A., Mississippi River Comn., 4th Dist., 3338 St. Charles Ave., New Orleans, for constructing about 13,000 cu. yds. of levee work in the Atchafalaya Levee District. Contract was awarded to KAISER & MALONEY, Plaquemine, La., at $2,210.

BANQUETTES.—Vicksburg, Miss.—The Fifth Louisiana Levee Board has awarded the following contracts: ROBERT NICHOLSON, at 23.90 cts. per cu. yd., for the Martin to Bedford banquette, in Madison Parish; and R. T. CLARK, of Natchez, Miss., at 17.9 cts. per cu. yd. for the Glasscock banquette in Concordia Parish.

SUBWAY.—Boston, Mass.—Bids will not be opened on Dec. 29 by the Boston Transit Commission for enlarging Haymarket Square station and subway and building sub-passageway to the Union-Friend station in and near Haymarket Sq., Washington St. tunnel, on account of a question of change of plans. H. A. Carson, Ch. Engr.

*WHARF.—Washington, D. C.—Bids were received by the Light-House Engineer, Baltimore, on Nov. 27, for furnishing materials and labor of all kinds necessary for the construction of a light-house depot wharf at the intersection of O and Water Sts., Washington, D. C. Contract was awarded to THOMAS BANKS, Washington, at $6,798.

PIER.—New York, N. Y.—Bids were received on Dec. 17 for Contract No. 1161: For furnishing all the labor and materials required for preparing, for repairing and rebuilding a portion of the West 35th St. pier, known as Pier 75, North River, Boro. of Manhattan. Contract has been awarded to the PHOENIX CONSTRUCTION CO., 41 Park Row, New York, at $35,897.

*PILE PIER.—Michigan City, Ind.—Bids were received by Maj. Thos. H. Rees, U. S. A., Chicago, Ill., on Dec. 12, for pile pier construction and removal of old pier in Michigan City Harbor, Ind. The Standard Construction Co., First National Bank Bldg., Chicago, was the lowest bidder, at $58,335. Bids in detail are given under Contract Prices.

*TILE DRAINS.—Peoria, Ill.—Bids were received by the Commissioners of the Hallock and Medina Drainage District of Peoria County, at the office of W. S. Kellogg, Attorney, 100 South Jefferson Ave., Peoria, Ill., Dec. 14, for furnishing and laying 31,737 ft. of drain tile ranging in size from 8 to 30 ins. diameter. Harman Engineering Co., 120 Fredonia Ave., Peoria, Engrs. Contract was awarded to DAILEY & BROWN, of Jacksonville, Ill., at $19,997.

CEMENT, BRICK, LUMBER.—New York, N. Y.—Bids are asked by John F. Ahearn, Pres. Boro. Manhattan, until Dec. 30, for furnishing and delivering 250 yds. of best Cow Bay sand; 75,000 best North River hard brick; 250 bbls. of Portland cement; 150 bbls. of Rosendale cement; 800 best spruce planks, 2 in. × 9 in. × 13 ft.; 600 best spruce planks, 9 in. × 1¼ in. × 13 ft.; 400 best spruce strips, 2 in. × 4 in. × 13 ft.; 100 best spruce joist, 2 in. × 6 in. × 13 ft.

MOORINGS, BUOYS.—Tompkinsville, N. Y.—Contracts have been awarded by the Light-House Inspector, Tompkinsville, for furnishing and delivering moorings for vessels and buoys of the Light-House Establishment for the fiscal year ending June 30, 1909. The articles to be furnished embrace chain for light vessels, to the SENECA CHAIN WORKS, Kent, Ohio, at $31,447; chain for buoys, SENECA CHAIN WORKS, $11,356; buoy shackles, FLETCHER & CROMWELL CO., Portland, Me., $8,647.

CRANES, BRASS.—Washington, D. C.—Bids will be received until Dec. 29 by the Bureau of Supplies and Accounts, Navy Dept., Washington, D. C., for furnishing at the various naval stations and navy yards the following supplies: Mare Island, Cal., Sch. 657—Three steam locomotive cranes. Puget Sound, Wash., Sch. 668—4,000 lbs. soft sheet brass, 1,300 lbs. spring brass wire; Sch. 670—cold drawn seamless copper pipe.

Also, until Jan. 12, Puget Sound, Wash., Sch. 679—Pipe expanding and flanging machine.

DREDGING.—Albany, N. Y.—Bids were received as follows by F. C. Stevens, Supt. Public Works, on Dec. 22, on Barge Canal Contract No. 20, which is for dredging a channel in the Mohawk River from Rexford Flats to Little Falls, a distance of over 58 miles. This is a readvertisement for bids since no bids were received on the former call: Sundstrom & Stratton, 90 West St., New York, $4,973,860; American Pipe Mfg. Co., 112 North Broad St., Philadelphia, $4,913,168. Itemized bids are given under Contract Prices.

YACHT.—Washington, D. C.—Contract has been awarded by the Carnegie Institute of Washington for the magnetic survey yacht "Carnegie," to the TEBO YACHT BASIN CO., foot of 23d St., Brooklyn. Henry J. Gielow, 50 Broadway, New York, is the naval architect and engineer in charge of the work and he is to be assisted by W. J. Peters, who formerly had command of the "Galilee" and is to have charge of the "Carnegie." The dimensions of this vessel are 155 ft. 6 ins. over all, 128 ft. 4 ins. on the water line, 33 ft. beam molded and 12 ft. 7 ins. draft. Total estimated cost, $125,000.

GRAIN.—Stonington, Ill.—Contracts have been awarded as follows by the Drainage Commissioners of District No. 4, town of Stonington, A. B. Chapman, Chn., for furnishing trenching, laying, etc., vitrified glazed tile. Total, about 54,025 ft. of 7-in. to 28-in. tile. J. W. Dappert, Engr., Taylorville, Ill. Tony W. Hooper, Town Clk.: Furnishing tile, the STONEWARE PIPE CO., East Alton, Ill., $17,597; hauling and distributing tiles, WALTER COFFEY, Stonington, $1,746, and trenching and laying, JOHN DROHN, 679 West Macon St., Decatur, Ill., $4,705. Total, $24,048.

FENCING.—New York, N. Y.—Bids are asked until noon, Jan. 12, by the Aqueduct Commissioners, 280 Broadway, for building, approximately 2¾ miles of iron and wooden fencing, with necessary gates, around Jerome Park Reservoir, City of New York, Boro. of the Bronx. Approximate quantities: 8,250 ft. iron fencing, 6 ft. high; 3,180 ft. iron fencing, 4 ft. high; 3,165 ft. wooden fencing, 6 ft. high; 15 iron gates; 6 wooden gates; 10 granite gate-posts; 225 cu. yds. concrete; 500 cu. yds. rock excavation; 500 cu. yds. earth excavation; 4,500 cu. yds. earth filling.

REPAVING PIER.—New York, N. Y.—Bids were received as follows on Dec. 17 by the Department of Docks and Ferries for furnishing all the labor and materials required for repairing and rebuilding a portion of West 35th St. pier, known as Pier No. 75, North River, Boro. of Manhattan. Phoenix Construction Co., 41 Park Row, $35,897; Snare & Triest, 143 Liberty St., $38,190; Butler Bros.-Hoff Co., 1170 Broadway, $45,000; Bernard Rolf, 39 Cortlandt St., $39,335; Wm. H. Jenks, 59 Pearl St., $41,696; P. Sandford Ross, Jersey City, $47,280; N. Y. Submarine Contracting Co., 130 Pearl St., $37,900; Geo. B. Spearin, $38,283.

BUOYS, ETC.—Tompkinsville, N. Y.—Contracts have been awarded by the Light-House Inspector, Tompkinsville, N. Y., for furnishing and delivering buoys and appendages for the light-house establishment during the fiscal year ending June 30, 1909, as follows: Bell buoys, P. DELANY & CO., Newburgh, N. Y., $12,765; spar buoys, JORDAN BROS. LUMBER CO., Norfolk, Va., $4,280; can and nun buoys, CANTON BOILER & ENGINEERING CO., Canton, Ohio, $10,376; tall type buoys, CANTON BOILER & ENG. CO., $4,464; whistling buoys, CANTON BOILER & ENG. CO., $5,784; iron sinkers, CHATTANOOGA CAR & FOUNDRY CO., Chattanooga, Tenn., $5,506.

COVERS, GRATES, RUBBER HOSE.—New York, N. Y.—Bids are asked until Dec. 30, by John F. Ahearn, Pres. Boro. Manhattan, for furnishing and delivering 100 cast-iron manhole heads, 500 cast-iron manhole covers, 200 cast-iron basin covers, 200 cast-iron hoods and plates, 50 cast-iron flat basin grate bars (corner), 250 cast-iron flat basin grate bars (side), 50 cast-iron herringbone grate bars (side), 200 cast-iron herringbone grate bars (side), 200 wrought-iron manhole step-irons.

Also for furnishing and delivering 3,500 ft. best 2½-in. rubber hose, in 50-ft. lengths, with all necessary couplings and rubber washers attached.

DITCH.—Burlington, Iowa.—Bids are asked until 2 p. m., Dec. 29, by the Joint Board of Supervisors of Louisa County and Des Moines County, Louisa-Des Moines Drainage District No. 4, at the office of Dan P. Hill, Auditor of Des Moines County, Burlington, for constructing an open drain, 2,400 ft. in length.

Bids were received on Nov. 14 by the Joint Board of Supervisors of Louisa and Des Moines Counties, at the office of Dan P. Hill, Auditor of Des Moines County, at Burlington, for constructing Sections 1 and 2, requiring 20,000 cu. yds. and 17,460 cu. yds., respectively, and Section 2, requiring 8,200 lin. ft. 18-in. and 2,400 lin. ft. 15-in. tile drain. Contract has been let to R. J. PHELPS, Carbon Cliff, Ill., at $21,595, for both sections. Harman Engineering Co., 120 Fredonia Ave., Peoria, Ill., Engrs.

DOCK.—San Francisco, Cal.—Bids were received by the Harbor Board on Dec. 10 for a dock to be constructed in the Central Basin, near Illinois St., and almost adjoining the Union Iron Works, on unimproved property. The new dock will have a surface area of 150,000 sq. ft., will rest on green piles protected with concrete. Estimated cost, $104,475. The lowest bidder was the Mercer-Fraser Construction Co., 1525 Mission St., San Francisco, at $57,741. The awarding of the contract will be postponed until Dec. 24. Meanwhile bids will be called for on a 15-year lease of the new wharf. The lessee will have to put up advance rent equal to the cost of construction, as was done in the case of the Pacific Mail and other leased wharves. This wharf will be especially adapted to lumber handling purposes. It must be kept in repair by the tenant and turned over to the State at the termination of the tenancy in good condition.

REPAIRING NAVAL VESSELS.—Washington, D. C.—The Secretary of the Navy has forwarded to Congress a schedule of repairs exceeding 20% of the cost of the vessel, or amounting to more than $200,000 in any one case, which the department desires to have made during the next fiscal year ending June 30, 1909. This is required by the act of 1907. There are ten vessels in the list, four being battleships and the other six cruisers, and the amount which the Secretary's communication to Congress asks to have appropriated for repairs on these vessels is as follows:

Battleship Maine, $520,000, in addition to the $200,000 authorized by the Naval Appropriation act of May 13, 1908.; battleship Missouri, $540,000; battleship Ohio, $540,000; battleship Wisconsin, $380,000; cruisers Chattanooga, Cleveland, Denver, Des Moines, Galveston and Tacoma, $210,000 each.

The Secretary states that the repairs on the following ships will exceed 20% of the total value of the ships involved, the amount wanted for each vessel being as follows: Concord, $152,000; Yorktown, $152,000; El Cano, $350,000; Paraguay, $20,000; Quiros, $30,500; Rodgers, $42,000; Rainbow, $140,000; Supply, $130,000, and the Yankee, which twice has been sunk, $195,000. The total amount of these repairs during 1910 is estimated at $4,154,500 for the vessels mentioned. New boilers are wanted for the Maine and the Wisconsin, and the boilers of the Ohio and the Missouri are to be retubed. It is the intention to modify the batteries and magazines of each of these battleships "to bring them into accord with present practice;" also to install ammunition hoists and other turret fittings.

U. S. POSSESSIONS AND CUBA.

POWER PLANT. — Hawaii. — Marston Campbell, Territorial Superintendent of Public Works will ask the Legislature, which meets in February, for appropriations sufficient to install a 12,000-HP. electric plant in connection with the Nuuanu Dam now nearing completion. The new reservoir will supply water with a 90-ft. head, which the Superintendent plans to use entirely for power, pumping the domestic supply for the city from artesian wells. The plans also contemplate using as a reservoir the concave crater of Punchbowl Hill, back of the city, which has an elevation of about 400 ft. The electric plant is also designed to furnish lights for Honolulu.

RAILWAY.—Hawaii.—The Honolulu Rapid Transit & Land Co. has announced that it will make a number of extensions of its service soon to connect with the various forts and military posts which are being built by the Navy and War Departments. Surveys have been completed for a line some six miles in length to connect with the new naval station at Pearl Harbor; and a branch also will be extended beyond the eastward of the city to reach the about completed at Diamond Head. Another branch probably will be extended into the military reservation at Waikiki Beach.

The Oahu Railway & Land Co. has ordered for the extension of its steel tracks to connect with tracks being laid by the government in the naval reservation at Pearl Harbor. It is stated that the Naval Station will have its own locomotive to handle the freight delivered to it by the railroad company. Railway tracks are also to be extended through the 14,000-acre military reserve 15 miles from Honolulu, to which a regiment of infantry and two squadrons of cavalry have lately been assigned.

WIRELESS TELEGRAPH.—Hawaii.—The Hawaiian Telegraph & Telephone Co. is the new name of the Wireless Telegraph Co., as just authorized by the Territorial Treasurer. The company has announced through C. J. Hutchins, Pres., the acquisition of the franchise of the Standard Telephone Co., and a contract with the Automatic Electric Co., of Chicago, for the installation of a new telephone system in Honolulu. The company at the present time operates the very efficient wireless telegraph system between the islands of the group, and the Kahuku station, which has established successful wireless communication with the mainland. The purchase of property for exchange purposes was recorded recently, and the statement is given out that an up-to-date telephone central station will be built on the site at once. The new telephone system will be of the automatic type, and the company will install a complete underground system of wiring. The project, it is stated, has been financed through the Metropolitan Trust & Savings Bank, of Los Angeles. The company is at the present time also experimenting with wireless telephony between the islands.

ENGINEERING SUPPLIES.—Panama.—Bids were received as follows Dec. 21, at the Isthmian Canal Commission, Washington, D. C., for furnishing a quantity of engineering supplies for use on the Isthmus: Seven marine boilers, for rock and sand barges: Coatesville Boiler Works, Coatesville, Pa., $13,000, 90 days; P. Delany & Co., Newburgh, N. Y., $14,175, 210 days; G. & W. Mfg. Co., 26 Cortlandt St., New York, $17,451, 150 days; Kingsport Foundry & Machine Works, Oswego, N. Y., $12,796, $12,292, 150 days; Harlan & Hollingsworth Corp., Wilmington, Del., $11,989, 80 days; Lake Erie Boiler Works, Buffalo, N. Y., $14,350, 110 days; Manning, Maxwell & Moore, New York, $13,195, 120 days; Marine Boiler Works Co., Toledo, Ohio, $12,963, 140 days; Maryland Steel Co., Sparrow's Point, Md., $13,825; I. P. Morris Co., Philadelphia, $13,475, 160 days; New York Shipbuilding Co., Camden, N. J., $15,500, 130 days; Phoenix Iron Works Co., Meadville, Pa., $12,700, 90 days; Pusey & Jones Co., Wilmington, Del., $12,859, 120 days; Springfield Boiler & Mfg. Co., Springfield, Ohio, $13,594, 150 days; Casey, Hedges Co., Chattanooga, Tenn., $12,600; National Electrical Supply Co., Washington, $13,013, 120 days; Robb-Mumford Boiler Co., South Framingham, Mass., $14,504, 110 days; Valk & Murdock Iron Works, Charleston, S. C., $16,800, 140 days.

Portland cement, 20,000 barrels: Alsen's Portland Cement Works, New York, $38,000, no time stated; Alpha Portland Cement Co., Easton, Pa., $28,150, 35 days; Atlas Portland Cement Co., New York, $29,400, 60 days6 William Wirt Clark & Co., Baltimore, $37,800, 90 days; Lehigh Portland Cement Co., Allentown, Pa., $28,300, 42 days.

30,000 sheets corrugated galvanized-iron roofing: Griscom Spencer Co., 90 West St., New York, $17,756; United States Steel Products Export Co., New York, $22,483; Youngstown Sheet & Tube Co., Youngstown, Ohio, $23,711.

2,000 rolls bronze wire screening: Clinton Wire Cloth Co., Clinton, Mass., $22,740, 225 days; W. S. Tyler Co., Cleveland, Ohio, $27,000; Wickwire Bros., Cortlandt, N. Y., $21,500; Francis T. Witte Hardware Co., New York, $40,500; New Freedom Wire Cloth Co., New Fredom, Pa., $22,635.

A quantity of flat machinery steel, various sizes: U. S. Steel Products Export Co., New York, $22,962; J. B. Kendall Co., Washington (part), $15,630.

A quantity of merchant bar iron, various sizes: Pancoast, Rogers & Richards, New York (part), $24,145; Pittsburg Forge & Iron Co., Pittsburg (part), $27,649; U. S. Steel Products Export Co., New York, $22,605; J. B. Kendall Co., Washington, $23,283; Susquehanna Iron Co., Washington, $21,961.

Readers' Wants

If you are in the market for material, equipment or supplies, and fail to find it in our advertising pages, send us full particulars, and we will gladly put you in touch with the right parties.

PRODUCER GAS PLANTS.—Chicago, Ill.—C. B. Boriand, 1508 Boriand Bldg., writes for information on producer gas plants.

MOTOR TRUCKS.—Lexington, Va.—W. J. Turner, Box 308, writes for information and catalogs of heavy gasoline motor trucks for hauling lime.

METAL SHOW CASE FITTINGS.—Dover, Del.—The Dover Lumber & Milling Co. has requested the names of manufacturers of metal show case fittings.

ELEVATING MACHINERY. — Lexington, Va.—We are advised that W. J. Turner, Box 308, desires information on elevating machinery for handling stone and lime.

SEPTIC TANK SYSTEMS.—Atlanta, Ga.—We are in receipt of a request from G. F. Hurt, 203 Equitable Bldg., for names of concerns manufacturing or installing septic tank systems.

ELECTRIC SMELTING FURNACES.—Jamestown, N. Y.—Bentley & Harrington, 615 Chadakoin Bldg., write us that they desire information concerning electric furnaces for smelting copper.

PORTABLE HOUSES.—Camajuani.—R. P. Rordem, C. E., has written us to ask for catalogs and price lists (approximate) from manufacturers of portable houses. The price lists are absolutely essential if further dealings are desired.

THE FIRM OF McDANIEL & TRIMMER has opened offices in the city of Vermillion, S. Dak., for the practice of civil engineering and architecture. Samples of building materials and trade catalogues concerning engineering and architectural materials, machinery, appliances, apparatus, etc., are desired and will be placed on file for reference use.

THE WOOD DRILL WORKS, Paterson, N. J., announce that they have appointed Harold L. Bond Co., of 140 Pearl St., Boston, Mass., as their exclusive agents for the sale of "Wood" Rock Drills in the New England States to take effect Jan. 1, 1909. The Harold L. Bond Co. has offices at 42 Broadway, New York City, in charge of Joseph C. Sealy.

THE HAMMOND IRON WORKS, Warren, Pa., U. S. A., have opened an office in Mexico City, Mexico, located at Cinco de Mayo No. 32, Room 222, with Francis E. Pratt in charge. The Hammond Iron Works are manufacturers of high-grade steel tanks and general steel plate work for the mining trade, railroad companies, oil refineries, etc., and any communication addressed to their Mexican office will receive prompt attention.

AN ORDER for 800 steel cars of a new type has been placed by the Duluth & Iron Range with the Summers Steel Car Co., of Fittsburg, delivery to be made during March and April. The cars will require approximately 80,000 tons of steel plate, 6,400 car wheels and 1,600 car trucks, and the construction work on them will be given to the Standard Steel Car Co. The cars are to be of the center dump type. Under the new design one man will be able to empty the entire car.

THE WATERPROOFING COMPANY, New York, is working on a contract covering all of the waterproofing in connection with the new Grand Opera House in Boston. The deeper portion of this waterproofing, including the boiler room, will be done with hydrolithic cement. The upper part of the waterproofing will be done by the tar felt method. This waterproofing will extend to a depth of 38 ft. below the curb and it will be necessary to resist a 28-ft. head of water.

THE NINE BUILDINGS of the Root & Van Dervoort Engineering Company and the Moline Automobile Company, allied concerns of East Moline, Ill., have been equipped with a new sprinkler system at a cost of $15,000. There are over 2,000 sprinkler openings in the respective plants and the danger of loss from fire has been greatly minimized.

HENRY SELS & CO. have removed their New York offices from 66 Broad St. to the West Street Bldg., 90 West St., New York City.

THE PHOENIX GLASS CO., of New York, Pittsburg and Chicago, has retained the Bureau of Illuminating Engineering, 437 Fifth Ave., N. Y., to act as consulting designing illuminating engineers, in the matter of designing and re-designing glass globes and reflectors, as manufactured by them, so that beauty and utility will be sensibly blended. Albert J. Marshall, Chief Engineer of the Bureau, will have direct supervision of this work. The Phoenix Glass Co., through the Bureau, will be pleased to supply technical data regarding their product.

THE PARTNERSHIP heretofore existing between John W. Page and E. R. Shnable, doing business as Page & Shnable, 1002 Security Bldg., Chicago, has by mutual consent, been dissolved. All outstanding accounts due to the scraper-bucket business will be collected by John W. Page, who will also pay all bills on the scraper-bucket account. Al outstanding accounts due to the contract business will be collected by E. R. Shnable, who will also pay all bills on the contract account. The address of John W. Page is 1002 Security Bdg., and of E. R. Shnable 2389 N. Paulina St., Chicago, Ill.

THE ROCK ISLAND CO. has placed the largest order for railway signaling given in the country, with one exception. It is for 1,250 miles of railroad, and was placed with the Union Switch & Signal Co., Swissvale, Pa. The plant of the signal company will be engaged one year in turning out the apparatus. The first instalment is for equipping the St. Louis & San Francisco road, 750 miles, which is a part of the Rock Island system, and was the first order placed. Then followed the Chicago, Rock Island & San Francisco order for 500 miles of electric signaling. The signal company recently completed a new plant, doubling its capacity.

THE RAYMOND CONCRETE PILE CO., of New York and Chicago, has been awarded the following contracts: Placing Raymond concrete piles in the foundations of the new post-office which is being erected at St. Louis, Mo., James Knox Taylor, Supervising Architect, U. S. Treasury Department; Bedford Stone & Construction Co., general contractors. About 55,000 ft. of piling will be required in this work. Another contract calls for the placing of Raymond concrete piles in the foundations of a grocery warehouse building for E. D. Depew at Canal and Greenwich Sts., New York; Radcliffe & Kelly, architects. The warehouse will be six stories in height, but the foundations are designed to support three additional stories should they be required.

THE CLEVELAND CRANE & ENGINEERING CO., Wickliffe, Ohio, announces several recent shipments: Two 10-ton 3-motor, 40'-0" span alternating-current cranes to the Puget Sound Navy Yard and one 10-ton, 3-motor 40'-0" span crane to the New Orleans Navy Yard; also one 75'-0" 15-ton crane to Dallas, Texas; two 20-ton, 3-motor cranes to the Isthmian Canal Commission for the Panama power houses; one 15-ton 3-motor 50'-0" span crane to the Erie Foundry Company, Erie, Pa. Among the cranes now under construction are three 10-ton 2-trolley 5-motor alternating-current cranes for the Sculley Steel & Iron Co., Chicago, Ill.; ten 3-motor 48'-0" span high speed cranes and two 10-ton 3-motor special trolleys for the Isthmian Canal Commission, and one 10-ton 3-motor crane for the Chicago Railways Co. One 20-ton 50'-0" span crane for export to Cuba is also being built.

THE WHITING FOUNDRY & EQUIPMENT CO., of Harvey, Ill., advises us that it has supplied the following equipment for the new plant of the American Car & Foundry Co., at St. Louis: Wheel pits, pitting trolleys, electric puller machines, transfer car for core oven, floor cranes, reservoir ladles, teapot spout wheel pouring ladles. It also advises us of the appointment of the following agents: United Steel & Equipment Co., Seattle, Wash.—Vancouver, B. C.; Portland, Ore., and State of Washington: Cupola furnaces, foundry equipment, air hoists, steel and malleable foundry equipment, in addition of crane agency. Gorman, Clancey & Grindley, Ltd., Calgary, Alta.—Province of Alberta and southeastern British Columbia, for the sale of electric traveling and other types of cranes of our manufacture, air hoists, cupola furnaces, and foundry equipment; also for steel and malleable foundry equipment.

THE REPUBLIC IRON & STEEL CO., Chicago, Ill., has organized a concrete engineering department consisting of a concrete constructor and concrete and mill engineers. Under the supervision of this department the company is making high grade rounds, squares, flats, and cold-twisted squares, especially for reinforcing purposes and of high values in tensile strength and ductility. Realizing the value of prompt shipments in reinforcing work, stock on hand of standard sizes of above material is carried at several mills. Mr. W. A. Collins, recently connected with the American System of Reinforcing, will have charge of the Concrete Reinforcing Department with offices at the First National Bank, Chicago, and will be assisted by D. J. Calkins, a thoroughly experienced concrete constructor. Mr. E. Lee Heidenreich, Consulting Engineer, will have charge of the engineering matters.

All matters relating to Concrete Reinforcing Steel may be addressed to the Republic Iron & Steel Co., Concrete Reinforcing Department, First National Bank Bldg., Chicago.

THE LAIDLAW-DUNN-GORDON CO., 115 Broadway, New York, has closed a contract with Stewart-Kerbaugh-Shanley Co. for a large air compressor plant to be used in connection with their contract, comprising some 14 miles of the new Catskill Mountain aqueduct to supply water for New York City. These compressors are to be of the motor-driven type, and are fitted with the well-known Cincinnati air valve gear. It is intended that this equipment be of the highest possible design throughout, and the Stewart-Kerbaugh-Shanley Co. in connection with the best engineering talent available, decided upon this type of plant, and the Laidlaw-Dunn-Gordon compressors as best adapted for their conditions. The matter of economy in operation, cost of maintenance and attention that the compressor equipment would require being the one important feature most considered; the matter of first cost being a secondary consideration throughout. This plant is similar in design to the two in operation by the United Engineering & Contracting Co., of New York City, and are similar in design to large compressor installations made by this company for S. Pearson & Son, Long Island City, and the Hudson Terminal Co., also of New York City.

ADVICES RECEIVED from the Scherzer Rolling-Lift Bridge Co. state that the new Scherzer rolling-lift bridge across the Ngawun River in Burmah is completed and opened for railroad traffic. This, the largest bridge constructed in Burmah, has a movable span 220 ft. long, the total length of bridge being 820 ft. The bridge is constructed on the main line of the Burma Railways extension connecting Rangoon with Kyngin. The Ngawun River is in the fertile delta of the Irawaddy River and forms a connection between this River and the Bay of Bengal. The Government authorities required the large movable span to expedite the railroad traffic and the heavy traffic on the river carried on by the Irawaddy Flotilla Company's vessels which traverse these waterways from the coast to the interior of Burma as far as Mandalay, more than 400 miles inland. The bridge was designed by the Scherzer Rolling-Lift Bridge Company, of Chicago and New York, and manufactured in England at the works of Spencer & Company, Melksham, Wilts, and erected in Burma under the charge of the engineers of the Scherzer Company. Though the difficulties to contend with were very great the bridge was completed within a year.

THE INDUSTRIAL INSTRUMENT CO. was organized by men who have long been engaged in the manufacture of measuring instruments. The leaders being Messrs. B. B. Bristol, E. H. Bristol, and W. E. Goodyear, all of Waterbury, Conn., who were for many years active in the development of the Bristol Company. The Messrs. Bristol, with several of their co-workers, withdrew from that company last spring, to develop a plan of larger scope and broader aims than was possible in that organization. Their plan involves the development of an extensive line of those types of measuring instruments and apparatus, the use of which promotes directly or indirectly, safety and economy of operation in industrial plants, and oftentimes makes possible, operations which without such instruments or apparatus would be impossible. It is proposed to concentrate all energies in the development and sale of a harmonious line of apparatus for this one broad economic field.

The Industrial Instrument Co., which was formed to achieve the above purposes, is a Connecticut corporation with authorized capital stock of $2,000,000. This company now owns the entire capital stock of the Standard Gage Manufacturing Co., until recently of Syracuse, N. Y., and of the Standard Electric Time Co., of Waterbury, Conn.

The Standard Gage Manufacturing Co. will be re-incorporated in Connecticut. It has purchased a plant at Foxboro, Mass., into which it has moved from its outgrown quarters at Syracuse.

The personnel of the organization includes instrument engineers of long experience, so that its engineering staff is capable of meeting successfully demands for apparatus of a special nature for particular conditions so long as it falls within the company's scope.

The sales end of the business will be carried on by the Industrial Instrument Co., of New York, which has recently been formed for this purpose. This company will handle the entire output of the Standard Gage Manufacturing Co., and also the industrial branch of the business of the Standard Electric Time Co.

Its officers are: President, Bennett B. Bristol, formerly secretary and treasurer of the Bristol Co.; Vice-President, Walter W. Patrick, until recently manager of the New York office of theBristol Co.; Secretary, Henry P. Dennis, formerly manager of the Chicago office of the Bristol Co.; Treasurer, Arthur F. Mundy, secretary and general manager of the Standard Gage Manufacturing Co.

The home offices will be located at Foxboro, Mass., with sales offices at 50 Church St., Hudson Terminal, New York, and 752 Monadnock Bldg., Chicago.

THE AMERICAN COAL PRODUCTS CO. announces that they have sold their by-product coke oven interests heretofore conducted by their subsidiary company, the United Coke & Gas Co., to the Oberschlesische Kokswerke & Chemische Fabriken Aktien Gesellschaft of Berlin, Germany, the transfer to take effect January 1st, 1909. A new company is to be formed to be called "The German-American Coke & Gas Co.," with headquarters at 17 Battery Place, New York. The capital will be $2,000,000. Of this $500,000 is to be paid in in cash at once, and the paid-in capital will be increased to $1,000,000 as soon as the needs of the business may demand it. The balance of the stock is to remain in the treasury for future needs. The Board of Directors of the German-American Coke & Gas Co. will be as follows: Baron Fritz von Friedlaender-Fuld, Chairman of the Board of Directors of the Oberschlesische Kokswerke & Chemische Fabriken; A. Zindler, Vice-President of the Oberschlesische Kokswerke & Chemische Fabriken; A. Nothmann, Vice-President of the Oberschlesische Kokswerke & Schemische Fabriken; Dr. F. Schniewind, Vice-President of the United Coke & Gas Co.; Henry H. Wehrane, of Hallgarten & Co., Bankers, New York; E. Thalmann, of Ladenburg, Thalmann & Co., Bankers, New York; Thos. M. Rianhard, Vice-President and Treasurer of the United Coke & Gas Co.; W. H. Childs, Vice-President of the American Coal Products Co.

The officers of the German-American Coke & Gas Co. will be as follows: W. H. Childs, Chairman; Dr. F. Schniewind, President; A. Zindler, Vice-President; F. Moser, of the Oberschlesische Kokswerke & Chemische Fabriken, Secretary and Treasurer. Director Wilhelm Altpeter, the head of the construction and operating departments of the Oberschlesische Kokswerke & Chemische Fabriken in Europe, will act as consulting engineer for the new company.

The American Coal Products Co. will have a stock interest in the German-American Coke & Gas Co.

The Oberschlesische Kokswerke & Chemische Fabriken is one of the largest by-products coke oven companies in Germany. The American Coal Products Co. will henceforth give its entire attention to the manufacture and disposal of tar products and ammonia.

The German-American Coke & Gas Co. comes into possession of all the by-product coke oven patents heretofore exploited by the United Coke & Gas Co., including the well-known Otto-Hoffman system, and the more recent designs known as the "United-Otto System" according to which more than half of all the by-product coke ovens in America have been erected.

CONTRACT PRICES.

PILE PIER.—Michigan City, Ind.—Bids were received by Maj. Thos. H. Rees, U. S. A., Chicago, Ill., on Dec. 12, for pile pier construction and removal of old pier in Michigan City Harbor, Ind. Itemized bids were as follows: (A) engineer's estimate; (B) Great Lakes Dredge & Dock Co., Chicago; (C) Standard Construction Co., First National Bank Bldg., Chicago; (D) Standard Contracting Co., Cleveland, Ohio:

	(A)	(B)	(C)	(D)
25 Oak piles, 35 ft. long, each	$10.00	$16.00	$12.50	$15.75
25 Oak piles, 30 ft. long, each	8.00	14.00	11.00	13.50
2,712 ft. B.M. oak cap timbers	60.00	75.00	78.00	58.00
2,712 ft. B.M. oak wales	60.00	75.00	85.00	58.00
4,536 ft. B.M. Oregon fir stringers	60.00	75.00	55.00	40.00
100 ft. B.M. Fir or pine triple lap sheeting	15.00	16.00	13.00	17.80
14,000 ft. B.M. fir or pine double lap sheeting	55.00	75.00	55.00	54.00
2,700 lbs. steel anchor rods	.05	.08	.05	.04
200 lbs. screw bolts	.05	.08	.05½	.04
1,100 lbs. drift bolts	.04	.08	.04¾	.04
50 lbs. wire nails	.04	.08	.05	.04
50 lbs. boat spikes	.04	.08	.05	.04
Total for constructing 100 lin. ft. pile pier	$3,512	$4,477	$3,554	$3,928
Total for constructing 900 lin. ft. pile pier	$31,612	40,295	31,985	35,356
Removal of about 1,550 lin. ft. old pier	20.00	22.00	17.00	28.77
Grand Total	$62,611	$74,395	$58,335	$79,950

DREDGING.—Albany, N. Y.—Bids were received by F. C. Stevens, Supt. Public Works, on Dec. 22, on Barge Canal Contract No. 20, which is for dredging a channel in the Mohawk River from Rexford Flats to Little Falls, a distance of over 58 miles. (This is a readvertisement for bids, since no bids were received on the former call.) Bids in detail were as follows—(a) Engineer's estimate; (b) Sundstrom & Stratton, 90 West St., New York; (c) American Pipe Mfg. Co., 112 North Broad St., Philadelphia, Pa.:

	(a)	(b)	(c)
Clearing (lump sum)	$1,000.00	$1,000.00	$1,000.00
2,385 cu. yds. grubbing	.40	.40	.45
8,420,000 cu. yds. excavation	.48⅛	.58	.57
20 M. ft. B. M. sheeting and bracing (per m. ft.)	50.00	50.00	60.00
1,000 lin. ft. round timber bracing	.06	.06	.25
34,300 cu. yds. embankment	.15	.15	.20
1,500 cu. yds. lining	1.50	1.50	2.00
75 cu. yds. second-class concrete	10.00	10.00	12.00
8,100 cu. yds. wash wall	1.50	1.50	2.00
7,400 sq. yds. first-class stone paving	3.00	3.00	3.50
2,097 cu. yds. first-class riprap	3.00	3.00	5.00
2,200 cu. yds. second-class riprap	3.00	3.00	4.00
600 cu. yds. third-class riprap	3.00	3.00	3.50
12,000 cu. yds. fourth-class riprap	2.50	2.50	3.00
Total	$4,173,000	$4,973,800	$4,913,168

INDUSTRIAL NOTES.

D. CUOZZO announces the removal of his general contracting offices from the World Bldg. to Room 630, Park Row Bldg., New York City.

THE STANDARD BOILER & PLATE IRON CO., of Niles, Ohio, have just completed the erection of a 10' 0" dia. by 50' 0" high standpipe at Montefiore Home for Consumptives at Bedford Station, N. Y.

THE C. A. MFG. CO., Austin, Texas, states that it has arranged with the Western Electric Co., of Denver, Colo., to maintain an agency in Denver for the sale of "C. A." Wood Preserver.

THE ATLAS DRYER CO., of Cleveland, has removed its offices from the Schofield Bldg., to the Citizens Bldg., where it would be glad to receive a call from any visitors to the forthcoming Cement Exhibition, to be held in Cleveland, who are interested in Atlas dryers.

R. L. TOTTEN, formerly with Meade & Huey, and Vann E. Ohl, City Engineer of Ensley, Ala., announce the formation of the firm of Totten & Ohl, Civil and Mining Engineers, with offices in the Louis V. Clark Bldg., Birmingham, Ala., and in the City Hall, Ensley, Ala.

THE PARKER BOILER CO., Philadelphia, Pa., announces the following jobs in process of construction: Two 150-HP. boilers for Herman Koenig Furniture Co., Chicago, Ill.; one 262-HP. boiler for Abbott Alkaloidal Co., Chicago, Ill.; one 300-HP. boiler for Thos. Devlin Mfg. Co., Burlington, N. J.

GEORGE T. PRINCE, member of Am. Soc. C. E., who has for the past five years been connected with the Denver Union Water Company as Chief Engineer, having left the service of that company, announces that he has opened an office at 528 Symes Bldg., as Consulting Engineer in all matters relating to hydraulic engineering.

ERNST WIENER CO., railroad specialists for all industries, announce that Mr. J. N. Richards, who for the last fourteen years was General Sales Manager for the Standard Paint Company, has associated himself with Ernst Wiener Co. Mr. Richards will make his headquarters for the present in the main office of the company, 50 Church St., New York City.

ENGINEERING MATERIAL PRICES.

TRACK FASTENINGS—

Pittsburg, f. o. b. cars—Angle bars, 1.65 to 1.75 cts.; spikes, standard sizes, 4½ × 9-16-in., at 1.70 cts. and smaller sizes at 1.80 cts. in carload and larger lots, with an advance of 5 cts. per 100 lbs. for less than carload, f. o. b. Pittsburg; bolts, square nuts, 2.65 to 2.75 cts.; hexagonal nuts, 2.80 to 2.90 cts.

RAILS, STEEL—

New York—at mill—New standard sections, $28; standard, second quality, $27 to $28; light sections, 12 to 14 lbs., $34 to $36; Per gross ton—Heavy melting steel scrap, $13 to $13.50; old steel rails, rerolling lengths, $15 to $15.50; relaying rails, $23 to $24; old iron rails, $18 to $18.50.

Pittsburg—Standard sections, at mill, $28; standard, second quality, $27 to $28; light rails, 25 to 45-lb. sections, $25; 20-lb., $26; 16-lb., $27; 12-lb., $28.

STRUCTURAL MATERIALS—

Pittsburg, f. o. b. mill—Beams and channels, 3 to 15-in., inclusive, 1.60 cts., net; I-beams over 15-in., 1.70 cts., net; angles, 3 to 6-in., inclusive, ¼-in. and up, 1.60 cts., net; angles, over 6 ins., 1.70 cts., net; angles, 3 × 3 ins. and up, less than ¼-in., 1.50 cts., base, half extras, steel bar card; tees, 3-in. and up, 1.65 cts., net; zees, 3-in. and up, 1.60 cts., net; angles, channels and tees under 3-in., 1.50 cts., base, half extras, steel bar card; deck beams and bulb angles, 1.90 cts., net; hand rail tees, 3 cts., net; checkered and corrugated plates, 3 cts., net.

Chicago—at mill—Beams and channels, 3 to 15-in., inclusive, 1.78 cts.; angles, 3 to 6-in., ¼-in. and heavier, 1.78 cts.; angles larger than 6-in., 1.88 cts.; beams, larger than 6-in., 1.88 cts.; beams, larger than 15-in., 1.88 cts.; zees, 3-in. and over, 1.78 cts.; tees, 3-in. and over, 1.83 cts.

New York—at tidewater—Beams, channels, angles and zees, 1.76 cts.; tees, 1.81 cts.; on beams, 18 to 24-in., and angles over 6-in., the extra is 0.10 cts.

PLATES AND SHEETS—

New York—at tidewater—Standard-sized plates—Sheared plates, 1.76 cts. to 1.86 cts.; flange plates, 1.86 cts. to 1.96 cts.; marine plates, 2.16 cts. to 2.26 cts.; fire-box plates, 2.65 cts. to 3.50 cts., according to specifications.

Pittsburg—mill shipment—Tank plates, ¾-in. thick, 6¼ ins. up to 100 ins. wide, 1.60 cts., base; blue annealed sheets, No. 10 and heavier, 1.80 cts.; Nos. 11 and 12, 1.85 cts.; Nos. 13 and 14, 1.90 cts.; Nos. 15 and 16, 2 cts. Box annealed, Nos. 17 to 21, 2.25 cts.; Nos. 22 to 24, 2.30 cts.; Nos. 25 and 26, 2.35 cts.; No. 27, 2.40 cts.; No. 28, 2.50 cts.; No. 29, 2.60 cts.; No. 30, 2.70 cts.; galvanized sheets, Nos. 10 and 11, 2.45 cts.; Nos. 12 and 14, 2.55 cts.; Nos. 15 and 16, 2.65 cts.; Nos. 17 to 21, 2.80 cts.; Nos. 22 and 24, 2.95 cts.; Nos. 25 and 26, 3.15 cts.; No. 27, 3.35 cts.; No. 28, 3.55 cts.; No. 29, 3.70 cts.; No. 30, 3.95 cts.

IRON—

Pig Iron:

At New York—tidewater—

Northern—			
No. 1 foundry	$17.50	to	$17.75
No. 2 foundry	17.00	to	17.50
No. 2 plain	16.00	to	16.50
Gray forge	15.50	to	16.50
Basic	15.50	to	16.25
Virginia—			
No. 1 foundry	17.10	to	18.15
No. 2 foundry	16.65	to	17.00
Basic	16.25	to	16.75
Southern—			
No. 1 foundry	17.50	to	17.75
No. 2 foundry	17.25	to	17.50
No. 3 foundry	16.75	to	17.25
No. 4 foundry	16.25	to	16.50
No. 1 soft	17.25	to	17.50
No. 2 soft	17.25	to	17.50
Gray forge	15.75	to	16.25
Mottled	15.50	to	16.00

At Chicago—f. o. b.—

Lake Superior charcoal	$19.50	to	$20.00
Northern—			
Coke foundry, No. 1	17.50	to	18.00
Coke foundry, No. 2	17.00	to	17.50
Coke foundry, No. 3	16.50	to	17.00
Scotch, No. 1	18.00	to	18.50
Southern—			
Coke, No. 1	17.85	to	18.35
Coke, No. 2	17.35	to	17.85
Coke, No. 3	16.85	to	17.35
Coke, No. 4	16.35	to	16.85
Coke, No. 1, soft	17.85	to	18.35
Coke, No. 2, soft	17.35	to	17.85
Gray forge	15.85	to	16.35
Mottled	15.60	to	16.10
Malleable Bessemer	17.00	to	17.50
Standard Bessemer	17.90	to	18.40
Jackson County and—			
Kentucky Silvery, 6%	19.90	to	20.40
Kentucky Silvery, 8%	20.90	to	21.40
Kentucky Silvery, 10%	22.90	to	23.40

At Philadelphia—

Eastern Pennsylvania—			
No. 2 X Foundry	$17.25	to	$17.50
No. 2 Plain	16.75	to	17.00
Virginia—			
No. 2 X Foundry	17.25	to	17.50
No. 2 Plain	17.00	to	17.25
Gray forge	15.75	to	16.00
Basic	16.50	to	17.00
Low Phosphorus	21.00	to	21.50

At Pittsburg—

Prices all f. o. b. Pittsburg—

No. 2 foundry	$15.40	to	$15.50
Gray forge	....	to	14.90
Besemer iron	16.40	to	16.90
Ferromanganese	47.00	to	47.50
Ferrosilicon	69.00	to	70.00

Cast-iron Pipe:

New York—Carload lots, net tons, 6-in., at tidewater, $24.

Chicago—4-in. water pipe, $27; 6-in. to 12-in., $26; over 16-in., $25, with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—

Copper:
Lake, 14.37½ to 14.50 cts.; electrolytic, 14.12½ to 14.25 cts.; casting, 14 to 14.12½ cts.
Lead: New York, spot, 4.25 to 4.30 cts.
Spelter: New York, spot, 5.10 to 5.15 cts.
Tin: New York, spot, 29.50 to 29.80 cts.

TRADE PUBLICATIONS.

SMALL ELECTRIC MOTORS.—The Emerson Electric Mfg. Co., St. Louis, Mo. Paper; 7 × 10 ins.; pp. 12; illustrated.

Small motors for general work are shown, with their application to printing, labeling and washing machines, and fans for house furnaces. Lists of motors, fans, pumps, etc., are given.

AIR COMPRESSORS.—Bury Compressor Co., Erie, Pa. Catalog No. 42. Paper; 6 × 9 ins.; pp. 52; illustrated.

This is a combination in one binding of catalogs No. 40 and 41. The general characteristics of the Bury compressor are completely described and the illustrations show center-crank and duplex compressors arranged for belt, steam or motor drive.

LOCK NUT FOR TRACK BOLTS.—Fifield Duplex Lock-Nut Co., Grant Ave., Medford, Mass. Paper; circular; 8 × 16 ins.; illustrated.

The nut is split, and pins on the rear part project beyond the front part. When the nut is screwed home, the pins strike the splice bar and spring the rear part of the nut so that it grips the thread of the bolt.

PORTLAND CEMENT.—Universal Portland Cement Co., Chicago and Pittsburg. Paper; 6 × 9 ins.; pp. 10; illustrated.

This bulletin (No. 55) describes a concrete sea-wall and the floating concrete caissons for the Algonma breakwater. It has also illustrations of concrete bridges and building, and an article on the surface finish of concrete.

MICA FOR LUBRICATION.—United States Mica Co., 240 La Salle St., Chicago. Paper; 4 × 9½ ins.; pp. 4.

The "Mica Flake Lubricant" is white mica ground fine for use in connection with lubricating oils. It is said to be a great improvement upon the use of oil alone, besides increasing the life of the oil. It is further claimed to be effective in cooling hot bearings while the shaft is running.

TRACK DEVICES.—Quincy, Manchester, Sargent Co. and National Railway Materials Co., Old Colony Building, Chicago, and 90 West St., New York. Paper; 6 × 9 ins.; pp. 16; illustrated.

The devices include step joints for connecting rails of different sizes; the Payzant tie-plate and guard-rail plate, in which the rails are held by wedges instead of spikes; guard-rail clamps and braces; rail braces; anti-creeping devices for rails, and the Samson rail bender.

THE WESTINGHOUSE DIARY, 1909.—A handy vest-pocket diary for 1909, neatly bound in morocco, has been issued by the Westinghouse Companies. It contains, besides the regular diary pages, a large number of useful reference tables for mechanical and steam engineers and information concerning some of the more recent developments in engineering practice. Applications for copies should be addressed to the Westinghouse Publishing Department at Pittsburg.

CONDENSERS AND AIR PUMPS.—Wheeler Condenser & Engineering Co., Cartaret, N. J. Paper; three bulletins, 8 × 10½ ins.; pp. 16, 24 and 32; all illustrated.

The first of these bulletins (No. 101) describes briefly the company's products and its facilities. No. 102 relates to surface condensers and their accessories. No. 103 relates to the Wheeler-Edwards patent air-pump for use with vacuum machinery. The apparatus is described somewhat fully, and the illustrations show different styles of the apparatus together with their application in large plants.

DESIGN OF CONCRETE RETAINING WALLS.—Corrugated Bar Co., National Bank of Commerce Bldg., St. Louis, Mo. "Designing Methods" No. 5. Paper; 5½ × 8½ ins.; pp. 28; illustrated.

This company, formerly the Expanded Metal & Corrugated Bar Co., is publishing a series of bulletins on designing methods in concrete. The above, No. 5, treats of retaining walls. An account of the bulletin, given in the issue of Dec. 3, wrongly gave the address as San Francisco. The company, even before it changed its name, had headquarters in St. Louis, and there the address still remains.

IMPERIAL PAVEMENT.—Imperial Road Co., Times Building, New York. Paper; 5 × 6½ ins.; pp. 15; illustrated.

This pamphlet unfortunately contains no specific information regarding the "pavement" put down by this company, further than that it has been in use for four years and a half in Kansas City without any expense for repair, and that it is superior to macadam. The title-page contains the misleading statement that the "Imperial pavement" is the "final choice of the U. S. Government, which rejects macadam." The basis for this statement appears to be that the company named above secured a contract for building the artillery road between Fort Leavenworth and Leavenworth City, Kans., over the advocates of macadam.

PORTLAND CEMENT.—Marquette Cement Mfg. Co., Marquette Building, Chicago. Paper; 6 × 9 ins.; pp. 6; illustrated.

The principal feature is a view of the combined Court-House and City Hall building in Chicago. The latter portion is now under construction and Marquette cement is being used in the foundation piers.

THE PROTECTION OF GRADE CROSSINGS was discussed recently at a meeting of the state railway commissioners of Illinois, Indiana, Wisconsin, Ohio and Michigan. The meeting was held in Chicago on Dec. 3, and resulted in the organization of the North Central Association of Railway Commissioners, to include the five states mentioned above. A committee reported in favor of legislation to give the commissions control of railway and highway grade crossings, with power to order the separation of grades and to apportion the expenses for this work. Provision should be made to restrict the construction of grade crossings and to require the elimination of a certain number of crossings each year. In the meantime, the existing crossings should be protected by proper safety devices. Another committee reported in favor of stringent legislation to check the general practice of trespassing on railway property, as trespassers represent a large proportion of the persons killed and injured on the railways. The new association elected officers as follows: President, C. L. Glasgow, of the Michigan Commission; Secretary, Wm. Kilpatrick, of the Illinois Commission.

MACHINE TOOLS.—Manning, Maxwell & Moore, 85 Liberty St., New York. Cloth; 9½ × 13 ins.; pp. 1174; illustrated.

Time was, almost within the memory of men now living, when the only machine tools for the working of iron were the lathe and the planer. It is an impressive illustration of the magnitude and complexity of the iron working industry at the present day that a single firm dealing in machine tools can publish a catalog so huge and comprehensive that it almost calls for a machine tool to handle it. The book weighs no less than 13 pounds and contains 1174 pages.

In the compilation of the book great care has been exercised in the classification. For example, the first 94 pages are devoted to machinery especially adapted for use in railway shops. Then come 31 pages devoted to shapers, 38 to planers, 16 to slotters and so on. The illustrations, typography, and presswork of the book are of the highest excellence. In fact we are assured that no less than $50,000 has been expended in the production of the work, which in itself an impressive illustration of the magnitude of the industry carried on by the firm which issues the book. It is noteworthy that tools with electric motors attached as tools designed for use with high speed steel are well represented in the book.

Situations Wanted

MECHANICAL ENGINEER AND DRAFTSMAN, eight years' experience machine design, power plants, factory equipment, etc., technical, open for engagement Jan. 1, 1909. Address "K. A. 26," Engineering News, New York. 26-1t

MECHANICAL ENGINEER—European graduate, 32, power plant, steel works, general machinery experience; hard worker, systematic, excellent investigator; good common sense, high education; would change as assistant engineer or designing draftsman. Address "O. A. 26," Engineering News, New York. 26-12t

WANTED—Position as Concrete or Construction Foreman; six years' experience in reinforced concrete buildings, foundations and concrete piles. At reference. Will go anywhere. Address "M. A. 26," Engineering News, New York. 26-3t

HYDRAULIC ENGINEER (22), I. C. S. student, western, with 20-in. Y-level outfit; 4 years' experience; very steady habits; will go anywhere as office-, level-, rod-, flag- or chainman; irrigation, power or water supply preferred. Address "I. A. 26," Engineering News, New York. 26-4t

Situations Open

MANAGER of New York Building Contractor's Office wanted; give fullest details, including all qualifications and experience. All answers held confidential. Address "L. A. 26," Engineering News, New York. 26-1t

WANTED—Good man for car designing, estimating and drafting. Address "P. A. 26," Engineering News, New York. 26-2t

WANTED—Experienced estimator and solicitor for architectural and ornamental iron work. A young, ambitious, able man can secure a permanent position with a well-known concern. Communications confidential. Address with full details in own handwriting "R. A. 26," Engineering News, New York. 26-1t

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